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SFU 0303

Schnellfrequenzumrichter
High Frequency Converters

Vector-Control

Content

Issue November 2021   **Rev. 2.1**

INHALT

1. Introduction

Due to its construction, the rotational speed of a 3-phase Asynchronous-AC-Motor is directly dependent on the frequency of the voltage and the number of poles. In case of a 3PH 50Hz voltage and a 2-pole motor, the nominal speed would be 50 rpsec * 60 = 3000 rpm.
In case of Synchronous-BLDC motors (brushless dc), the speed is directly dependent on the voltage applied.

3-phase AC motors provide numerous benefits in industry, such as brushless operation, freedom from wear and tear, favorable capacity/weight ratio, high-speed capability, and much more. These motors can be used many different application areas, such as milling and grinding spindles, or with drilling machinery, for example.

✓ This unit is designed **for operation in industrial environments only**. When used in residential and commercial areas, additional measures may be required to limit the emitted interference (→ 5. / 12.)

The advantages of SFU0303 compared to similar converters:

✓ It is equipped with a Safe Power Stage Pulse Inhibition, authorized to current regulations EN 954_1 Categorie 3 corresponding to EN ISO 13849-1 Safe Torque Off One (ST01) = PLd / Cat 3

✓ High output power (3,6kV @ 230V) in compact case style

✓ High efficiency by symmetrical PWM

✓ Real time vector control for sensorless operation

✓ Maximum Torque even at lowest rotational speeds

✓ High possible acceleration rates for short process times. For example 25.000rpm/sec with a 2,2 KW Motor (with robotic applications)

✓ Pulse-Amplitude (PAM = Block-Modus) Control possible because of regulated intermediate voltage control (on option)

✓ Very low current consumption because of real time power control

✓ Easy Integration into new and existing PLCs because of flexible I/O configuration

✓ Various interface options: Profibus, RS485, RS232, USB

✓ Easy reversing the direction of rotation by software without loss of power.

✓ Autotuning function for spindle setup.

✓ Testrun with graphical documentation of voltages and currents of the spindle

✓ Up to 16 different spindle characteristics can be stored

✓ Very user-friendly debugging interface for setup control

✓ Start/Stop Interface for periodical tests or remote control

- ✓ Operating panel is detachable and can be used as remote control together with an extension cable.

- ✓ Cloning capability of the whole project setup with the help of the Operating Panel

- ✓ Designed for roughest use in industrial environment

- ✓ Specific construction of the SSE-housing realized without ventilations slots and an outside mounted heatsink prevents intrusion of dirt and chips of tooling into the control unit.

- ✓ Very compact case style makes easy cabinet mounting possible

- ✓ Several case options for cabinet mounting (SSE) , 19" rack style and desktop, or special designs on request

- ✓ User friendly Screw-plug connector system for power-, spindle- and I/O connectors.

- ✓ Wide range of operating voltage 115V-230V

- ✓ Automatic deceleration of the spindle down to standstill in case of mains failure by "Back Energy" Function

- ✓ Plain text messages and information on LC-display in amber color

- ✓ Very user friendly operation menu.

- ✓ USB connection and RS232 with specific adapter cable

- ✓ Full functional without operation panel in remote configuration

- ✓ Remote control hand-terminal available

- ✓ Temperature controlled fan

- ✓ Datalogger-Function on option available in combination with PC software SFU-Terminal. Records of all relevant parameters of the converter in nearly infinite lengths are possible down onto the PC- hard disc.

2. Description and Features

✓ Operation of **Asynchronous-AC und Synchronous-BLDC** Motors

✓ The high frequency converter SFU-0303 makes possible **output frequencies 500.000 rpm** with 2pole AC-Motors and with BLDC-Motors up to **100.000 rpm**

✓ **High output power (3,6kV @ 230V / 2kVA @ 115V)** in **compact style**

✓ The core of SFU-0303 is a **Digital Signal Processor** (DSP) which produces all output signals and collects all input signals

✓ All parameters like current, voltage and frequency are captured in **real time** and are regulated by the implemented vector control depending on the load condition.

✓ **High precision sinusoidal** output signals with low distortion factor realize very high accuracy in true running behavior.

✓ Allows highest **efficiency** of the spindles at **low and high frequencies**

✓ High **operational safety**: All operating conditions like acceleration, operation with nominal rotational speed, deceleration are monitored and critical conditions are intercepted.

✓ **STO Function** for highest safety at standstill and protection against unintended starting

✓ **Integrated heavy duty brake-chopper-resistor** for quick braking even from high speeds.

✓ **Transparency**: The user is always informed about the current status of the converter and the spindle on a plain text 3-line operating panel.

✓ **Control:** If needed, the converter can be controlled and parameterized manually with a pluggable operating panel.

✓ Easy **reversing the direction of rotation** by Software **without loss of power**.

✓ **Individual adjustment** to the current application and the connected spindle. Up to 16 different characteristics can be stored in the converter

✓ **A variety of options for control and communication possibilities**: For communication with peripheral devices, such as PC, PLC or CNC, there are 3 ports available:

✓ **Easy and flexible integration** into existing equipments by free configuration of I/Os
Control inputs: 2 Analog, 6 Digital
Control Outputs: 2 Analog, 6 Digital (Relay)

✓ **Galvanic separation** of all interfaces from each other and from mains / spindle potential

✓ **Short circuit proof**

✓ **Comfortable Configuration** und control with the help of a PC-Windows software "SFU-Terminal"

✓ **Cloning-Function with operating panel:** Creating of clones of converters by individual read out of the SFU-parameters into the operation panel and download into another or multiple SFUs.

✓ Automatic spindle calibration by **autotuning function**

3. Block Diagram
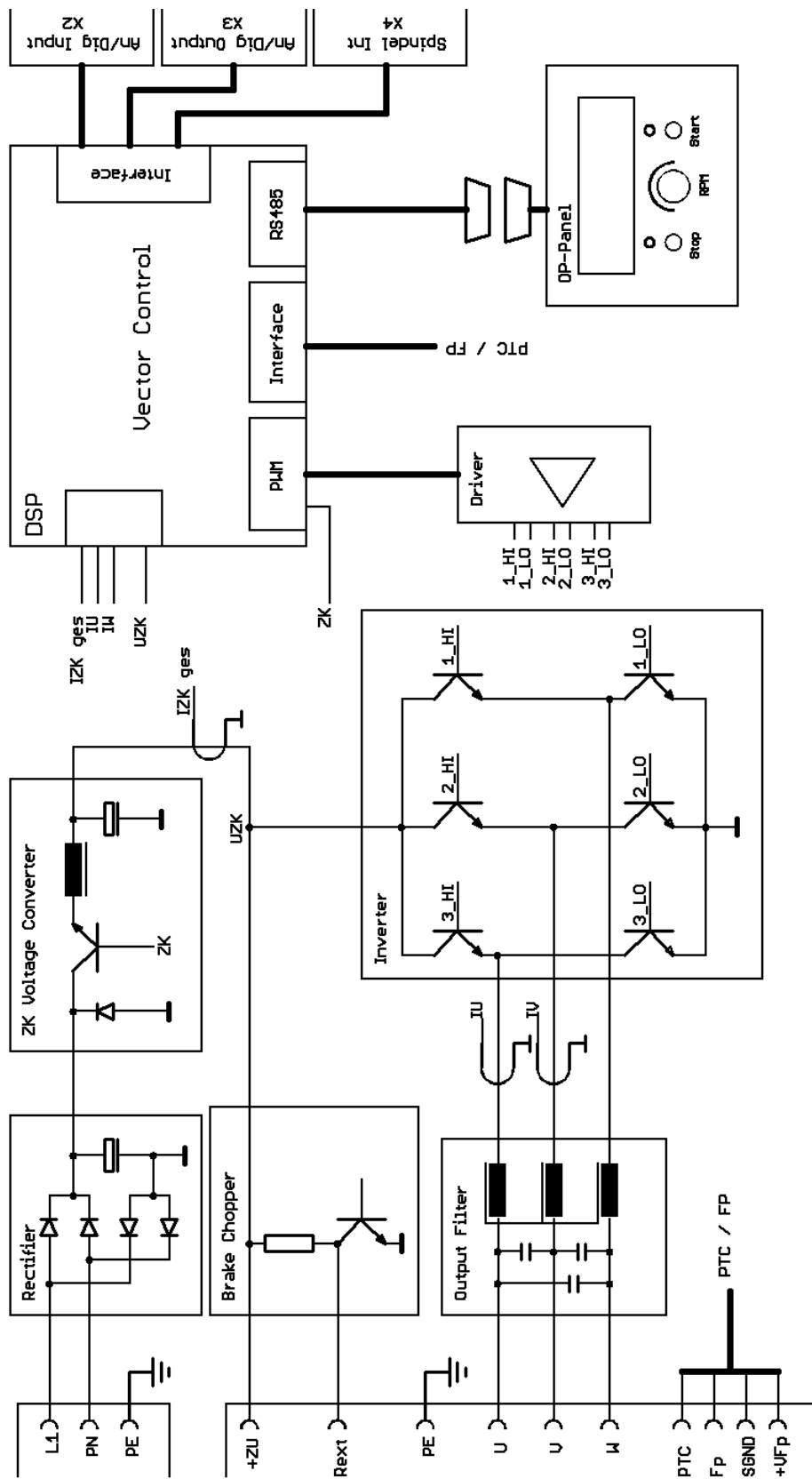
4. Technische Daten

4.1 Version SSE

Mains connection	115V, 60Hz	230V, 50Hz
	3-pin: plugable screw terminals 4mm²	
Continuous output power	2 kVA / S1-100%	3,6 kVA / S1-100%
Motor connection	10-pin: plugable screw terminals 4mm² PE, U, V, W, Temperature sensor, FP, SGND	
Output voltage	110V	220V
Output current	elektronically limited, max. 13A	
Output current overload	maximum duration adjustable 0…20sec	
Output frequency	AC: max 8,8kHz / 500.000 rpm DC: max 1.667Hz / 100.000 rpm	
Spindle characteristics	max. 16, stored internally	
Spindle sensor inputs	Speed sensor, PTC, KTY, PT1000	
Control inputs	2 Analog: 0-10V 6 Digital: 0-24V 2 STO: 0-24V	
Control outputs	2 Analog: 0-10V 5 x Digital, freely to be setup 1 x Digital reserved for power stage impuls inhibitor or STO Relay contacts, 24VDC/1000mA, 125VAC/500mA 12 pin plugable screw terminals X3	
Interface	- USB on operating panel (USB-Mini) - RS232, RS485 on SFU (9 pol DSub male) - Profibus on Option as module, replacing operating panel	
Dimensions	see chap 17	
Weight	approx. 6 kg depending on version	
Protection	IP20	
Operating conditions	5 - 40°C / rel. humidity max. 85%	

⚠ **ATTENTION**
The operation of a spindle with a wrong characteristic may harm the spindle or converter severely! Please ensure to have the proper characteristic selected always!

4.2   Version 19" und Desktop

Mains connection	115V, 60Hz 3-pin: plugable screw terminals 4mm²	230V, 50Hz
Continuous output power	2 kVA / S1-100%	3,6 kVA / S1-100%
Motor connection	9-pin: plugable screw terminals 4mm² U, V, W, Temperature sensor, FP, SGND, 2x PE Circular connector 7 or 13 Pin U,V,W,FP,SGND,Shield, PE	or
Output voltage	110V	220V
Output current	elektronically limited, max. 13A	
Output current overload	maximum duration adjustable 0…20sec	
Output frequency	AC: max 8,8kHz / 500.000 rpm DC: max 1.667Hz / 100.000 rpm	
Spindle characteristics	max. 16, stored internally	
Spindle sensor inputs	Speed sensor, PTC, KTY, PT1000	
Control inputs	2 Analog: 0-10V 6 Digital: 0-24V 2 STO: 0-24V	
Control outputs	2 Analog: 0-10V 5 x Digital, freely to be setup 1 x Digital reserved for power stage impuls inhibitor or STO Relay contacts, 24VDC/1000mA, 125VAC/500mA 12 pin plugable screw terminals X3	
Interface	- USB on operating panel (USB-Mini) - RS232, RS485 on SFU (9 pol DSub male) - Profibus on Option as module, replacing operating panel	
Dimensions	see chap 17	
Weight	approx. 6 kg depending on version	
Protection	IP20	
Operating conditions	5 - 40°C / rel. humidity max. 85%	

⚠️ **ATTENTION**
The operation of a spindle with a wrong characteristic may harm the spindle or converter severely! Please ensure to have the proper characteristic selected always!

5   Intended Use / Safety Instructions and Warnings

✓   This device produces dangerous electrical voltages and is used for the operation of fast spinning tools. Because of their high rotational speed, it may be dangerous in case of improper handling. For this reason, only professionally trained and qualified personnel should be allowed to work with and setup this device!

✓   Before the first commissioning can be carried out, it should be ensured that the spindle and the tool are fixed properly, to eliminate all dangers because of uncontrolled movement of the spindle.

✓   Safety regulations being valid for the country where the device is used, have to be adhered to where any work is carried out on the device.

✓   Before the device is turned on for the first time, it should be verified, that the connected parts cannot carry out uncontrolled movements.

✓   The frequency converter must not be operated close to heating devices or magnets or devices generating strong magnetic fields.

✓   Sufficient air circulation around the converter should be ensured.

✓   Fluids should be prevented from intruding into the housing. If it seems to be happened, the converter has to be switched off immediately.

✓   The ambient air must not use aggressive, flammable or electrically conductive substances and should be as free of dust as possible.

✓   All repairs and maintenance on the converter and the relating accessories must be carried out by skilled personal and with powered off, only. To ensure this, the mains plug should be pulled out. In doing this, both the terms of regulations for preventing accidents and the general and national rules for mounting and safety have to be applied.

✓   Do not open this device while it is connected to power supply. There is danger of life!
     With opening this unit the period of warranty will be ended.

✓   All people who work with this device should be trained and instructed by their line advanced technician.

⚠️   **Version SSE has no internal fusing. It has to be fused externally**

⚠️   **Please ensure, that PE protective earth is connected at the mains side. The device must not be operated without properly connected PE!**

⚠️   **Please ensure, that PE protective earth is connected at the spindle side as well as at the converter side!**

⚠ ATTENTION
Please verify that all power supply voltages are correct in polarity and value.

⚠ ATTENTION
Please ensure to have the proper characteristic selected, always!
The operation of a spindle with a wrong characteristic may harm the spindle severely!

⚠ ATTENTION
In case of replacing the fuses, please ensure to use types only, which are
mentioned in 'Technical Data'!

6 Connections, Interfaces and Pinouts

For embedding into PLC and controls the SFU0303 has several input and outputs.
They are realized as pluggable screw terminals and are located at the front or rear panel (depending on case option). All contacts are separated galvanically from high voltage carrying circuits.

Operational parameters and outputs:
The **SFU-0303** captures all current important operational parameters and operating data.
Up to 6 digital outputs can be used for signaling and up to 2 analogue values can be output to the analogue outputs (0-10V).

Remote Control and Outputs:
6 digital inputs (24V) and 2 analogue inputs (0-10V) are available for remote control of the **SFU-0303**.

These assignments can be configured freely. By using the optional Windows PC software "*SFU-Terminal"* the above mentioned assignments can be achieved easily, providing exceptional flexibility with each application.
Each operating parameter can be assigned as a signal and each control signal can be assigned to a certain I/O pin. In addition, the logic level (high or low active) can be individually defined.
The same assignment is also possible for the analogue measured data and control data at the analogue I/O pin.

The standard allocations of operational parameters, their outputs, control signals and inputs, are listed in the following tables.

6.1 Digital and Analog Inputs Version SSE: X2 (10 pin pluggable screw terminal)
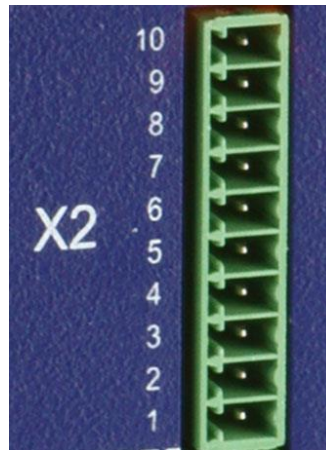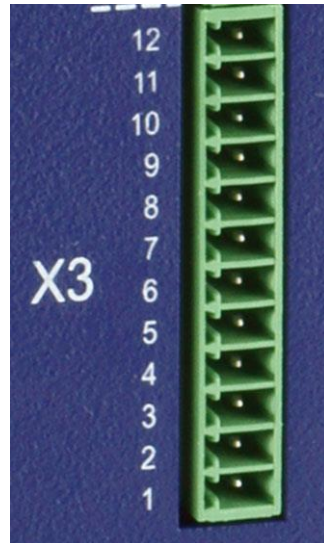

Pin	Description	Description	Function / default Setting	Switching state
1	Digital In 1	Input	**Start / Stop**	"0" Stop / "1" Start
2	Digital In 2	Input	**Power Stage Pulse Lock Inhibitor / no function with Version STO**	"0" activated / "1" released
3	Digital In 3	Input	**Power Stage Off**	"0" Aus / "1" On
4	Digital In 4	Input	**Locked / Emergency Stop**	"0" released / "1" Emergency Stop
5	Digital In 5	Input	**Error reset**	"0" Errors have to be reset, with Hi level on this Input or with any Start signal "1" Errors are rest automatically
6	Digital In 6	Input	**Direction of rotation**	"0" unchanged / "1" inverted
7	Analog In 1	Input	**Set value Rotational speed** Scaling 10V min/max	rot. speed converter 1V/10.000
8	Analog In 2	Input	**Set value Varioload**	active load 1V/10.000
9	GND		Reference Ground for die Digital and Analog signals	
10	+ 24V/50ma	Output	Auxiliary voltage supply	

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal.

✓   Switching level digital inputs: Log"0" = 0…7V   /   Log"1" = 18….24V   SPS Standard level

✓   Analogue input range: 0…10V

✓   The +24V at Pin 10 can be used as auxiliary voltage supply for Start / Stop signal with the help of a relay or for an electronic spindle interface.

6.2 Digital and Analog Outputs Version SSE: X3 (12 pin Pluggable screw terminal)

Pin	Description	Direction	Function / Message / default Setting
1	Relay Common		Common Rail Relay 1...5
2	Relay 6 normally closed	Output	Feedback signal for **Power Stage Pulse Lock** state
3	Relay 5 normally closed	Output	**Excess temperature** Converter of Spindle
4	Relay 4 normally closed	Output	**Overload**
5	Relay 3 normally closed	Output	**Standstill** Converter and Spindle
6	Relay 2 normally closed	Output	**Spindle Ready**
7	Relay 2 normally open	Output	
8	Relay 1 normally closed	Output	**Converter Ready**
9	Relay 1 normally open	Output	
10	Analog Out 1	Output	
11	Analog Out 2	Output	
12	Hall Sensor-Output	Output	modified signal square shape signal from encoder

The Reference-Ground for digital and analog signals: Clamp terminal X2.9

The Default-settings of the functions for the outputs can be set up freely with the help of the   PC-Software SFU-Terminal.

An exception is the signal "Power Stage Pulse Lock", which is linked fix with Relay 6.   According to the switch state it will be output 0V / GND or +24V via 10kΩ referring to GND   (X2.9) (-> 8.2 / 8.7)   +24V: Output Power Stage released   0V: Output Power Stage locked.

✓   Relay Output:
   1) default = "not energized" corresponds to "not active"
      ⇨ inactive condition at opener (NC contact)   → Contact closed
      ⇨ inactive condition at closer (NO contact)   → Contact opened

2) With SFU-Terminal the "active" function of the relays can be changed to "not energized " also. By this an inversion is achieved, with the restriction that this is applied to the inverter during operation at POWER-ON, only, because it is just realized by software. At POWER-OFF, the relay contacts have the default setting as in 1)

✓   The digital outputs (Relay1...5) are galvanically separated (500V$_{Isolation}$).
    DC: 24V / 1000mA   AC: 125V / 500mA

✓   Output level Speed / Hall Sensor: 0-24V (24V Level)

6.3   Spindle Interface - Version SSE: X4 (9 pin Pluggable screw terminal)
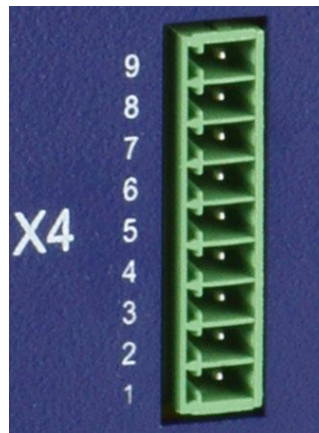
Pin	Description	Direction	Function
1	+12V/50mA	Output	Auxiliary voltage supply
2	Spindle GND		Reference Ground for Speed- and Temp-sensor
3	NC		not connected
4	FP/Speed sensor	Input	Input for 2/3-wire speed sensors / Hall sensors from spindle
5	Temperature Sensor	Input	Temperature signal from spindle: PTC, KTY, PT1000
6	Bit 4	Input	Characteristic selection by digital inputs
7	Bit 3	Input	Characteristic selection by digital inputs
8	Bit 2	Input	Characteristic selection by digital inputs
9	Bit 1	Input	Characteristic selection by digital inputs

The Default-settings of the functions for the inputs can be set up freely with the help of the PC-Software SFU-Terminal. The inputs of the encoder and the PTC are fix wired.

✓ The spindle interface is separated with optocouplers from all other signals. It can be used for an automatic spindle detection, if activated. The logic levels are low-active by default:

✓ "HI" > PIN connected with Spindle-GND, "LO"- > PIN unwired
   In the menu "Digital Inputs" this can be changed.

✓ GND signal X4 is electrically isolated from GND X2

✓ The temperature sensor input is provided to detect overtemperature on the spindle. With linear temperature sensors (KTY, PT1000), the switching thresholds for the error messages "Spindle overtemperature" can be freely defined using the SFU terminal. If PTC is selected, it will be triggered as soon as the PTC resistance is > 600Ω. In both cases, it is switched off after the delay time has expired

✓ The input 4 for the speed sensor works in the range of +/- 1V with a common mode range of 0..10V.

✓ The +12V at Pin 1 can be used as auxiliary voltage supply

✓ Spindle characteristic remote controller / Characteristic selection by digital inputs

✓ In SFU - Terminal main menu the spindle characteristics remote control can be enabled . In this case, the manual selection is inactive
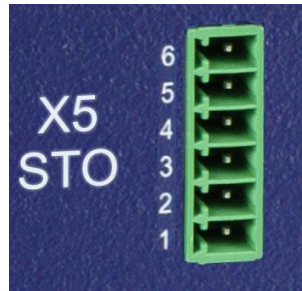
The addressing is binary coded: KL-Nr. "Value+1"

Bit 4	Bit 3	Bit 2	Bit 1	Spindle characteristic
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
		………		
1	1	1	1	16

ex.: all Pins open   0000 = 0 + 1 → Characteristic 1
                          0101 = 5 + 1 → Characteristic 6

The number of the selected spindle characteristic is displayed on the display at the right top.

6.4 Safe Torque Off – STO: X5 (6 pin Pluggable screw terminal)

Pin	Name	Direction	Function
1	STO Status	Contact 1	STO Status Feedback Relay / normally open contact
2		Contact 2	
3	GND STO-B		GND for STO-B , Chanal 2
4	STO-B	Input	Input STO-B Pulse Blocking Channel 2
5	GND STO -A		GND für STO-A , Kanal 1
6	STO-A	Input	Input STO-B Pulse Blocking Channel 1

✓ STO Channels 1 and 2 and the feedback Contactare isolated galvanically from each other and to all other I/Os.

✓ The STO-Inputs tolerate voltage levels of ±60-V and are reverse protected, with the and have reverse polarity protection that meets the characteristics of IEC 61131-2 types 1, 2 and 3.

| Level STO-A/B	0…5V = low	5,1V…..14,9V	15…30V (max. 60V) =high
State STO	STO active	not defined	STO inactive
	Converter is locked	not defined	Converter is ready
Relay contact	open	not defined	closed

✓ The relay contact between Pin1 and 2 is potential-free and serves as feedback signal about the STO channels

Attention:

The feedback contact is realized as single channel only. So it may only be used for monitoring purpose and must not be used within safety circuits.

✓ The feedback contact is open in case of STO is active → converter is locked

- With no signal or 0V at the control inputs STO-A and STO-B
- With no signal or 0V at one of the control inputs. → STO-Error
- If the power supply for the logic is missing

✓ The feedback contact is closed in case of STO is inactive → converter is unlocked

Details →7.9

6.5   Mains and Spindle connection at SSE
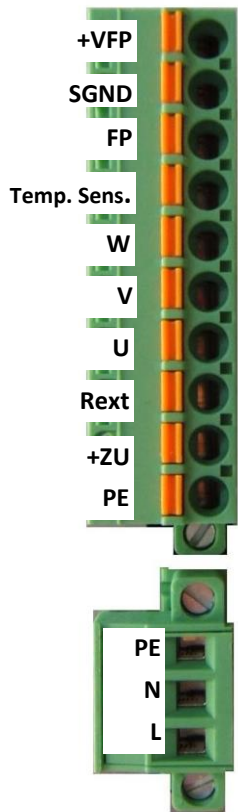
Pin	Name	Direction	Function
1	+VFP	Output	Auxiliary voltage supply 12V/50mA
2	SGND		Ground reference for FP, temperature sensor
3	FP	Input	Input for 2/3-wire speed sensors / Hall sensor
4	Temp-sensor	Input	Temperature signal from spindle: PTC, KTY, PT1000
5	W	Output	Spindle Phase W
6	V	Output	Spindle Phase V X4
7	U	Output	Spindle Phase U
8	Rext	Output	External Brake resistor / Chooper Resistor
9	+ZU	Output	Intermediate voltage (! Attention, High Tension!)
10	PE	Output	Connection for protective earth of spindle ! **Safety** !

+VFP
SGND
FP
Temp. Sens.
W
V
U
Rext
+ZU
PE

Name	Function
PE	Protective Earth ! **Safety** !
N	Neutral
L	Line Phase

PE
N
L

View at screen terminals at version SSE:
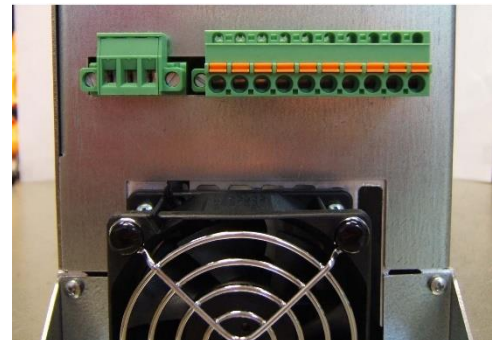
⚠ **Version SSE has no internal fusing. It has to be fused externally**

⚠ **Please ensure, that PE protective earth is connected at the mains side. The device must not be operated without properly connected PE!**

⚠ **Please ensure, that PE protective earth is connected at the spindle side as well as at the converter side!**

⚠ **Control wires, Mains cables and spindle cables should be installed separately.**
For wiring, the use of shielded cables is recommended.

6.6 I/O Interface - Digital and Analog In- and Outputs
19"Version and Desktop: (D-Sub 25pin female)

Pin	Description	Direction	Function / Massage / default Setting
1,14	Relay Common		Common Rail for Relay contacts
2	Relay 1 Normally Closed	Output	
15	Relay 2 Normally Closed	Output	
3	Relay 3 Normally Closed	Output	
16	Relay 4 Normally Closed	Output	
4	Relay 5 Normally Closed	Output	
17	Relay 6 Normally Closed	Output	Feedback signal for **Power Stage Pulse Lock** state r
5	Relay 1 Normally Open	Output	
6,18	+24V/50mA	Output	Auxiliary voltage for active field plates
7,19	GND		
20	Relay 2 Normally Open	Output	
8	Hall Sensor	Output	Modified signal from speed sensor
21	Digital In 2	Input	Power Stage Pulse Lock
9	Digital In 6	Input	
22	Digital In 5	Input	
10	Digital In 4	Input	
23	Digital In 3	Input	
11	Digital In 1	Input	
24	Analog In 1	Input	
12	Analog In 2	Input	
25	Analog Out 1	Input	
13	Analog Out 2	Input	

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal.

An exception is the signal "Power Stage Pulse Lock", which is linked fix with Relay 6. According to the switch state it will be output 0V / GND or +24V via 10kΩ referring to GND (7, 19) (-> 8.2 / 8.7)
+24V: Power Stage released   0V: Power Stage locked.

✓ The digital outputs (Relay1...5) are galvanically separated (500V$_{Isolation}$).
DC: 24V / 1000mA   AC: 125V / 500mA

✓ Switch level digital inputs: 0..7V = "0" / 18..24V = "1"

✓ Analogue input range 0...10V

✓ Output level Speed / Hall Sensor: 0-24V (24V Level)

✓ +24V at Pin6, 18 may be used as auxiliary power supply for e.g. an electronic spindle interface

## 6.7   Spindle Interface - 19"Version and Desktop: (D-Sub 15pin female)

Pin	Name	Direction	Function
1	nc		not connected
9	+12V/50mA	Output	Auxiliary voltage supply
2,1	SGND		Ground reference for FP, temperature sensor
3,11	Bit 0	Input	Characteristic selection by digital inputs
4,12	Bit 1	Input	Characteristic selection by digital inputs
5,13	Bit 2	Input	Characteristic selection by digital inputs
6,14	Bit 3	Input	Characteristic selection by digital inputs
7,15	Temp-sensor	Input	Temperature signal from spindle: PTC, KTY, PT1000
8	Hall Sensor	Input	Speedsensor signal from spindle

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal. The inputs of the encoder and the temperature sensor are fix wired.

✓   The spindle interface is separated with optocouplers from all other signals. It can be used for an automatic spindle detection, if activated. The logic levels are low-active by default: "HI" > PIN connected with Spindle-GND, "LO" > PIN open. In the menu "Digital Inputs" this can be changed.

✓   The temperature sensor input is intended for detecting overtemperature at the spindle. With linear temperature sensors (KTY, PT1000), the switching thresholds for the error messages "Spindle overtemperature" can be freely defined using SFU-Terminal. If PTC is selected, this is triggered as soon as the PTC resistance is > 600 Ω. In both cases, it is switched off after the delay time has elapsed

✓   The input 4 for the speed sensor is working within the range of +/- 1V with a common mode range of 0..10V.

✓   The +12V at Pin 1 can be used as auxiliary voltage supply.

(→ see 6.3)

6.8 Mains and Spindle connection - 19" Version:
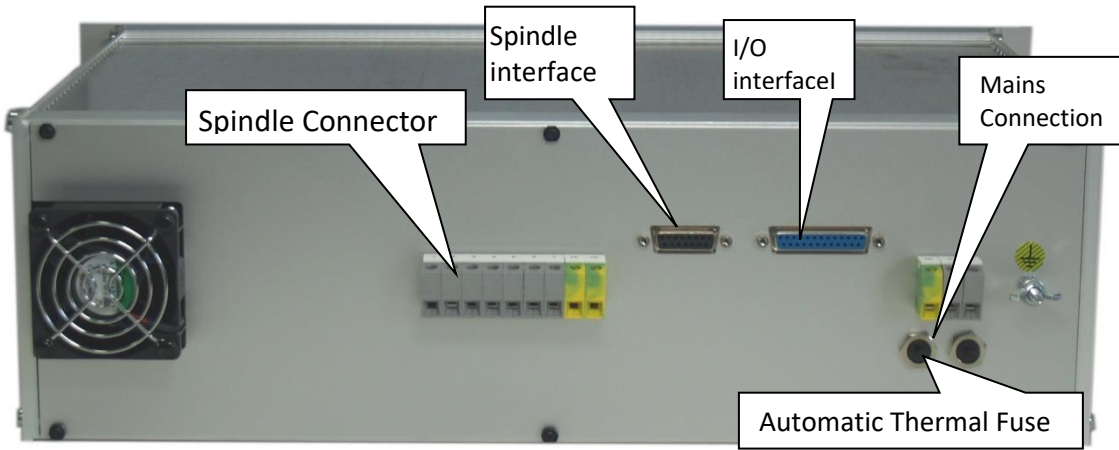
Back side SFU0303-19" with spindle connector clamp terminal

Spindle Connector - 9pin clamp terminal

Pin	Name	Direction	Function
1	+VFP	Output	Auxiliary voltage supply 12V/50mA
2	SGND		Ground for signals FP, PTC
3	FP	Input	Input for two/three wire-speed sensors
4	Temp-sensor	Input	Temperature signal from spindle: PTC, KTY, PT1000
5	W	Output	Spindle Phase W
6	V	Output	Spindle Phase V
7	U	Output	Spindle Phase U
PE	PE		Connection for protective earth of the spindle ! **Safety** !
PE	PE		

Mains connection - 3pin clamp terminal

Name	Function
PE	protective earth ! **Safety** !
N	Neutral
L	Phase

⚠️ **Please ensure, that PE protective earth is connected at the mains side, always. The device must not be operated without properly connected PE!**

⚠️ **Please ensure, that PE protective earth is connected at the spindle side as well as at the mains side, always.**

⚠️ **Control wires, Mains cables and spindle cables should be installed separately.
For wiring, the use of shielded cables is recommended.**

6.9 Mains and Spindle Connection - Desktop Version:

The connection with mains network is carried out with an IEC connector
The device is equipped with a Thermo-Automatic Fuse for each prong. They can be reset after tripping by pressing down the button

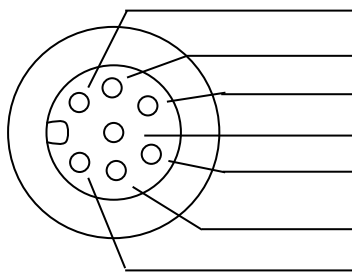The spindle connection is realized on custom order and can be realized accordingly
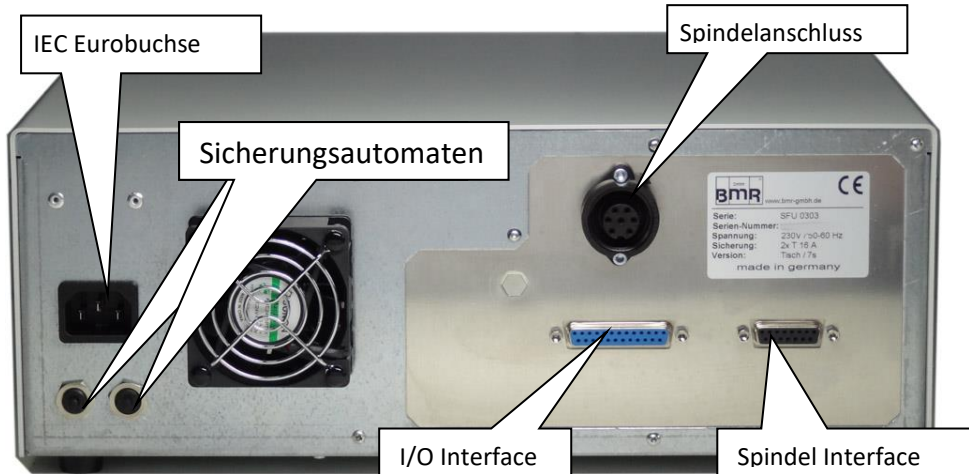
Backside SFU0303-Desktop equipped with a 7pin circular spindle connection

## Several Circular Connectors can be mounted:

Spindle Connection   7pin female Binder Series 693 or Amphenol C16-1

Pin	Name	Description
6	SGND	Signal GND for TempSensor- and FP-Signal
5	W	Spindle Phase 3
4	FP	speed sensor of the spindle
7	PE	Protective Earth
3	V	Spindle Phase 2
2	Temp-sensor	Temperature signal from spindle: PTC, KTY, PT1000
1	U	Spindle Phase 1

**Control wires, Mains cables and spindle cables should be installed separately.
For wiring, the use of shielded cables is recommended**

Spindle Connection　　　13pin female Binder Series 694
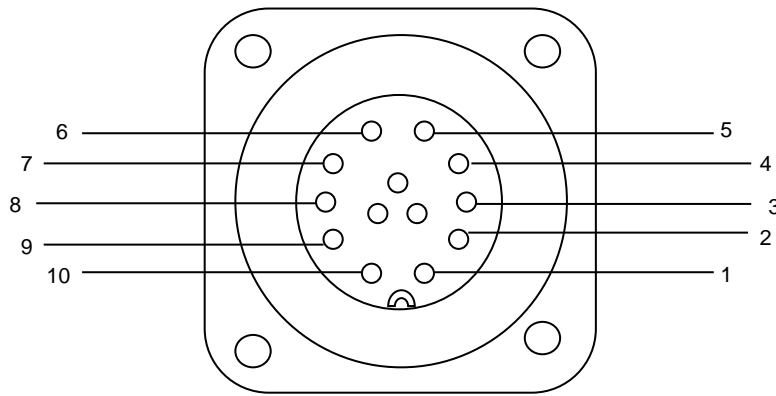
Pin	Name	Description
PE	**PE**	Protective Earth
1	**U**	SpindlePhase 1
2	**V**	Spindle Phase 2
3	**W**	Spindle Phase 3
4		NC
5	**SGND**	Signal Ground Speed Sensor, PTC
6	**FP**	Speed Sensor of the spindle
7	**PTC**	Temperature Sensor of the spindle
8		Shielding Control Wire 2x
9		Shielding all
10	**UH**	Auxillary Voltage +12V/40mA
11		NC
12		NC

⚠️ **Control wires, Mains cables and spindle cables should be installed separately.**
For wiring, the use of shielded cables is recommended.

6.10 RS232, RS485 - X1 - Version SSE (9pol D-Sub female)

At SSE devices the connection X1 INTERFACE is provided for the **operating panel**.
A RS232 and a RS485 interface is wired to this connector.

With disconnected operating panel a connection to a PC or any control can be established with a **specific BMR cable**.
! Attention, a standard RS232-cable won't work here and may harm the device or the PC !

The operating panel is fixed with 2,5mm Allen screw to the SFU0303. After unfixing the operating panel can be removed.

Additionally it can be used as a remote control in conjunction with a 1:1 cable. It is recommended not use lengths beyond 2m.

Pin	Function
1	Release
2	NC
3	A-RS485
4	RxD-RS232
5	GND
6	+5V-RS
7	NC
8	B-RS485
9	TxD-RS232

6.11 RS232 – at 19" or Desktop Version (9pol D-Sub male)

On option 19" or desktop devices might have a RS232 Interface on the backpanel. This interface shares the functionality with the USB Interface. For that reason it can be used **alternatively**, only

Pin	Function
1	
2	RxD
3	TxD
4	
5	GND
6	
7	
8	
9	

6.12 USB-Connection and RS232-#2

For easy connection and communication, the device is equipped with a USB interface. At the version SSE it is located at the bottom side as USB Mini AB. At the 19" and Desktop devices, it is found at the front panel directly below the display.

On option 19" or desktop devices might have a RS232 Interface on the backpanel. This interface shares the functionality with the USB Interface. For that reason it can be used **alternatively**, only
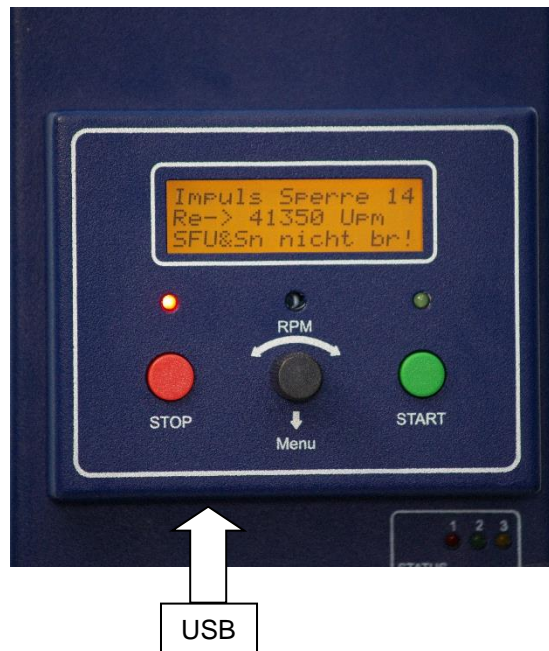
As an option, an additional RS232 on a DSUB 9 is also available (pinning as > 6.11).
Mounted below the USB connector into the front panel.
It is linked with the USB and can be used alternatively only

7 Functions, Commissioning, Operation

7.1 Front panel SSE, Desktop and 19" Version

Version SSE with STO

Version Desktop

Version 19"

7.2   Basics and Preconditions for Operation

7.2.1   Spindle Characteristics

All converters of BMR need an information about the basic data of the spindle, such as maximum voltage, current, rotational speed, and many more. These are stored in so called "spindle characteristics". A BMR spindle characteristic has 16 setpoints within the range of the rotational speed. At every point data of voltage, current, load scaling, acceleration and deceleration ramp and many more data can be defined and this for idle load as well as for full load. And there are in total 16 places for different characteristics. The spindle characteristics are the key for any spindle and give a possibility to control the running behavior at every load condition.

In advance of start of a spindle first, it has to be ensured, that the proper characteristic is selected and activated. This is generally the case if the device is delivered together with a spindle and the required setup is done. If the converter and spindle are delivered separately, the proper spindle characteristic has to be loaded into the converter first. This can be achieved with the free setup software SFU-Terminal, easily.
In case of being unsure, characteristics for most common spindles are available at BMR.

The spindle characteristics can be defined either in the project file (* .ps5) or via a setting in the operating panel (-> 7.4 Setup) .
Spindle characteristics are created by BMR and can be loaded and managed using the SFU - Terminal.

7.2.2   Remote spindle selection via Digital Interface X4

With the activation of the remote control interface is X4 (6.3 / 6.6) a control via the digital inputs Bit1 ... Bit4 to X4 possible. The setting in the project file or via the operator panel is then ineffective, however. Please refer to 6.3 and 6.6

7.2.3   Start and Stop

There are different possibilities for starting and stopping SFU0303, due to many different requirements, as follows below:
Generally, a STOP can be triggered by the source of START, with the exception of an Emergency Stop, activated Intermediate voltage lock or any other safety function.

✓   Start button at operating panel, Rotational speed with encoder potentiometer

✓   Pure serial control with commands via USB / RS232 / RS485 / Profibus interface
     A list is of commands is available on the website.

✓   Digital input in combination with an activated analogue input for control of rotational speed. In case of not being activated, the rotational speed is setup with encoder potentiometer on operating panel or via serial commands.

✓   Analog control with voltage at the speed reference input. Similar to the digital control, with the exception, that here is already activated the Start input

7.2.4 Safety functions: Power stage pulse lock or STO/Safe Torque Off

✓   The SFU0303 series is equipped with safety functions for safe standstill and against unintentional startup. This is also referred to as power stage pulse lock or inhibit in the following. This can be a single channel version or a dual-channel version

✓   A single-channel pulse lock inhibitor (→ 7.8) is integrated in the SFU as standard function.

✓   Alternatively, a dual-channel pulse lock (→ 7.9) in accordance with Safe Torque Off Standard STO is also possible in accordance with Stop Category 0 as in IEC 61800-5-2. This is implemented via an additional module.

✓   These safety functions are only alternatively installed and in function. With an STO module, the single-channel pulse lock is automatically inactive.

✓   The precondition for the correct start behavior is a correctly controlled, enabled pulse lock as well as the suitable characteristic curve for the connected motor.
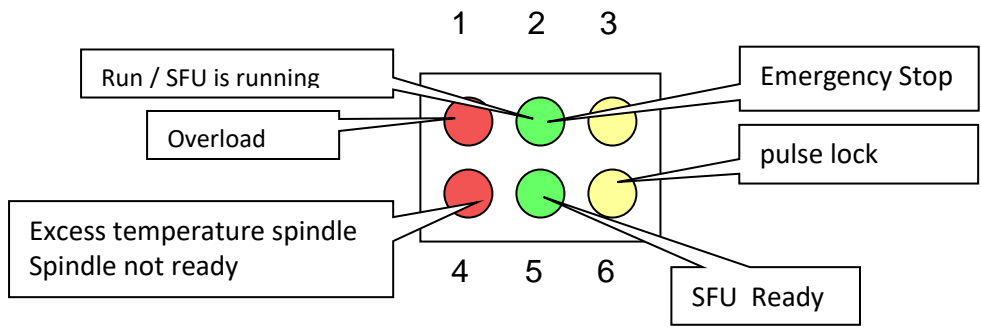
    Attention:
    For operation, these must be wired accordingly. Otherwise, the device cannot be put into operation.
    (→7.7 Safety functions)

7.2.5 Status display

    The current status of the converter is displayed on the status LED display and with mounted operating panel the status is displayed in plaintext on the LCD-display, additionally.
    (→ 7.4 Setup) .

7.3 Status LED Display

Typical displays. Other combinations are possible due to status and have to be decoded

 Converter and Spindel ready

Standstill

 Converter Ready / Ready

Spindle is spinning

 Converter Ready / Spindle is spinning

Overload

 Emergency Stop or Locking active

 Converter Ready / Spindle is spinning

Excess temperatur Converter

 GND fault /Short circuit with PE

 Converter Ready / Spindle is spinning

Excess temperatur spindle

 Pulse lock active

SFU locked

 STO active

SFU locked

 STO Error

LED 1/4 ON
LED 3/6 blink

Bild 15

A Start can be initiated with display "Converter and Spindle". There are different means for solving errors which are listed in Chap. "Troubleshooting".
The most probable reason for problems is a not properly wired input for "Emergency Stop" or "Intermediate Lock". In this case it is recommended to check the setting in the menu "Digital Inputs" in SFU-Terminal

7.4 LCD-Operating Panel
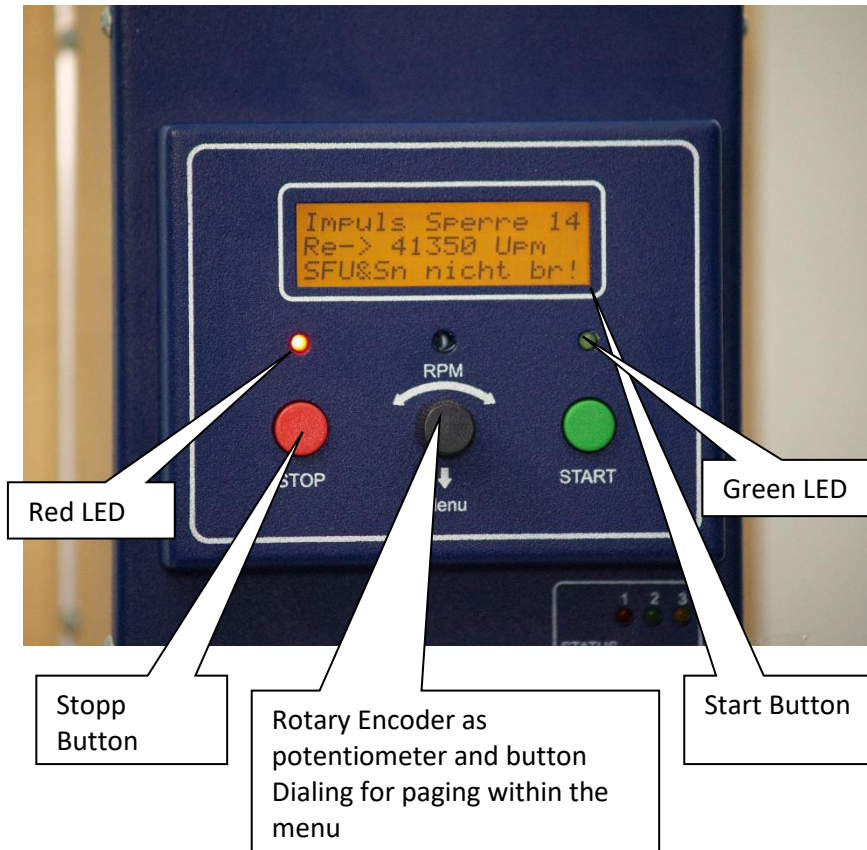
Line1:
- Info
- Nr. of the selected spindle characteristic

Line 2:
- Display of direction of rotation
- Current rotational speed of SFU or set value preset "rpm"
- Current Real-Speed   "rpmSP"

Line 3:
- Load display in %,
- Status display

Red LED

Green LED

Stopp Button

Rotary Encoder as potentiometer and button Dialing for paging within the menu

Start Button

7.4.1 Operating Elements:

Start-Button
For Starting the spindle

Stop-Button
For Stopping the spindle or ending the menu function

Encoder Potentiometer und Menu-Button with multifunction
During standstill and run mode the set value for speed can be setup by dialing
Short pushing during run mode switches on the debug mode.

Long pushing during standstill opens the setup menu
Dialing selects the menu item and
Short pushing selects the function.

Automatic ending of the menu after 10sec without manipulation or
short pushing of the Stop-Button

LED green
for indication of *Ready for Operation* or of *Run mode* und *Spindle is spinning*
LED red
for indication of *Standstill* or of *Stop mode* or *Error*

7.4.2 Setup-Menu / Menu Functions:

With pushing rotary button for more than 1sec the setup menu will be entered.
After that and releasing the button the following menu items can be selected by dialing

Display	Function
Direction of Rotation	Changing the direction: NonInverse / Inverse
Selection of Spindle Characteristic	Display of the stored spindle characteristics 1..16
Debug Modus	Anzeige von Netzspannung/Strom und Spindelspannung für 30sec
Version Info	Display of Firmware Versions of converter and operating panel in Line 2 and 3 for 5sec
Language	Selection of the display language German, English, French
Contrast	Setup of the display contrast
Read Config	Upload the project data from the SFU into the operating panel (→ Cloning)
write Config	Download the project data from the operating panel into the SFU (→ Cloning)
ESC	Leave Menu

With the rotary encoder a menu item can be selected which will flash if it is active.
By pushing the Menu-Button, the current item or the final entry is selected.
With ESC or pressing the Stop-Button or after approx. 10sec without activity the menu is quit without changes. The display returns to standard operating mode.

The adjustment of direction of rotation and the selection of the characteristic are possible during standstill, only.

In case of activating the menu during run mode, the spindle will be stopped after 5sec. for safety reasons.

Attention: Selecting the function Write Config the currently stored project data of the SFU will be overwritten without warning. By this a cloning of several SFUs can be carried out easily. Please verify, if this is really intended and if there are loaded proper project data into the memory by a previously Read Config operation.

Characteristic 3 is selected
preset speed 25.000rpm
Standstill, Direction CW = Non Inverse

```
Standstill  !      3
CW →   25000  rpm
Conv&Spin ready !
```

Converter is accelerating
Power output 67%

```
                   3
Outp.  7830  rpm
|||||||_____  67%
```

Spindle is running at set value of duty speed
Power output 20%

```
Duty speed OK   3
CW →   25000  rpm
||_____ 20%
```

Any error is displayed in plaintext in line 1
Converter has switched off

```
Overload           3
Outp.  25000  rpm
Conv. not ready !
```

7.4.3 Error Messages:

The following error displays are possible:

Display	Error
Pulse Blocking!!	Power stage lock active / converter locked
STO Pulse Blocking	Power stage lock STO active / converter locked
STO Error	Uneven signal on STO inputs / converter locked
Overload Stopp	Spindle Overload. The admissable maximum power is superceeded
Overtemp. SFU	Overtemp converter
Overtemp. Spin	Excess temperatur in spindle or temp input not properly wired
Overvoltage trip!	Mains voltage too high
Undervoltage trip	Mains voltage too low
Undervoltage stop	Mains voltage too low
Pwr stage off!	Power stage switched off and disabled
Emgcy stp active !	Emergency input engaged / converter locked
No Spindle !	Without spindle or cable defective
RS232 Error !	Timeout serial interface
Diagram Error !	Invalid characteristic
Encoder Error !	Error with speed sensor / hall sensor
Back engy trip	Error Power Stage switch off because of deceleration ramp too high
Err. B.Eng/Stall	Error with BLDC spindle: Spindle is blocked or has lost commutation
GND fault !	Error: PE is connected with one or more spindle lines or convert is defective

7.4.4 Operation and Adjustments:

Adjustment of the Rotational Speed:

dialing right or left with rotary encoder pot. Current value is displayed steadily. This can be the setup value before start or the current value during run.

Start/Stop:

with Start/Stop button. If the operating unit is removed during the start process the converter automatically turns into stop condition.

Debug Mode

During operation the debug mode can be entered by shortly pressing on the Menu-Button. It will be displayed the rectified mains voltage, spindle current and spindle voltage.
After 30sec of inactivity it will be returned to the standard mode, automatically.
With an additional pressing the debug mode is ended and it will be returned to the normal mode, but with displaying of the real spindle speed in place of the set value of the converter speed. This is indicated with "rpmSP". This persists permanently unless a further pressing of Menu-Button, which will return to the display of set value of the converter speed ("rpm")

```
U Netz      318 V
Strom       5,1 A
Uspin        78 V
```

Cloning (with SSE Version only)

With the menu-item "Read Config" the configuration of a converter can be read out into and stored within the non volatile EEProm memory of the operating panel. By swapping this   panel to another converter this configuration can be copied into this converter with the menu item "Write Config". This is a very easy method to copy one configuration to many other converters (cloning) without any PC. But it has to be taken care that, this is not carried out without having read out any configuration before, because transferring an empty or corrupted configuration into the converter, will cause severe problems!

Vario Load

is a variable limit value based on the load current, which can be setup and adjusted in SFU-Terminal in the   Menu "Analog inputs".
In menu "Digital outputs" this function can be linked to a relay .
Once this value is reached, the relay is switched.
In case of exceeding this value it makes possible, to realize a broken tool detection or to detect an worn tool and to indicate a change becomes necessary.

7.5 Start / Stop

There are four possibilities to start the spindle:

✓ **manually** with the Start/Stop buttons on the operating panel and the rotary knob for adjusting the rotational speed (see 7.6)

✓ **digitally** with a digital control signal at digital input1 **Start/Stop** at SL2.1.
The switching levels for "OFF=0" are 0...7V and for "ON=1" 18...24V,
voltages between 7V and 18V are undefined.
➔ As soon as this is initiated, the spindle will be accelerated to the set value of the rotational speed which is pre-selected as voltage at analogue input1 **Set Value of Rotational Speed** at SL2.2.

✓ **analogue** with a voltage at analogue input1
Precondition is a valid "ON" signal at digital input1 **Start/Stop**
➔ An input voltage of 0V makes the spindle stop, and a voltage higher than 0,29V starts the spindle up to a rotational speed according to the scaling.

✓ **serial** with start-stop commands via serial interface.

Start and Stop

In the simplest case, a connected and appropriately set up spindle can be started by pressing the Start-Button. The desired speed can be adjusted by dialing with the rotary knob either as preset value during standstill or in Run mode. The preconditions for a correct Start can be looked up under 7 and 7.1 .

Any error or malfunction is displayed as plain text

All relevant system messages on rotational speed, load or problems are displayed on the LCD display

The current power output is displayed in the lower part as analogue load bar as % and absolute.
An overload condition will be displayed as well.

The pre selected and current speed, the selected characteristic are displayed

> **ATTENTION:**
> **The operation of a spindle with an incorrect spindle characteristic may harm the spindle severely!**
> **Please ensure that the correct characteristic is selected**

> **If several spindles are operated simultaneously, it has to be ensured that they are of the same type and that a specific characteristic is selected.**
> **Otherwise this may harm one or more spindles or the converter severely!**

7.6   Adjustment of Rotational Speed

The preset of the rotational speed can be achieved by two ways:

✓   **manually preset with menu keys**
For this, the Option-Button ⬚0⬚ in the line Duty speed in the grey field in the menu "**Analogue-Inputs**" of SFU Terminal Software has to be activated. By this all analogue inputs were switched to inactive and no analogue signal is selected for Start.
The set value for rotational speed is displayed at the LCD-Display and can be adjusted with the rotary encoder. The speed of change is dependent on the speed of dialing. The rotational speed can altered during operation, also.

✓   **preselection with a voltage applied to the analogue input   SetValue Rotational speed**
For this, an analogue input has to be assigned to this function, which can be done in SFU Terminal Software in the menu "**Analogue-Inputs**". Additionally it has to be selected a scaling for the analogue voltage in the listbox field at left. 3 scalings are possible: 1V/10.000rpm or 1V/1.000rpm or 0-10V min/max).
The value of the rotational speed according the scaling is displayed on the LCD-display and can be altered as wanted.
An input voltage of 0V leads to Standstill and a voltage > min voltage will make the spindle start up to the speed according to the current scaling.
A scaling 1V/10.000 and a voltage of 4V will cause a speed of 40.000 rpm.

All settings made in SFU-Terminal have to downloaded into the SFU before they are valid with the button ⬚Write only I/O (F6)⬚.

7.7   Safety Functions

The menus described in the following refer to the SFU-Terminal software.

Automatic shutdown

- The following incidents lead to a **controlled braking and decelerating** to standstill of the spindle according to its acceleration times defined in the spindle characteristic.

✓ Stop due to **excess temperature at the spindle**, in case this function is activated and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..excess temperature spindle"
In the "Spindle characteristic" this function can be activated with the Check-Button Temp. sensor and according delay time can be setup in the menu "Delays"

✓ Stop due to **excess temperature of the converter**, in case this function is activated and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..excess temperature converter"

✓ Stop due to **overload** and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..overload" The limit values for overload are determined in the spindle characteristic. Generally for S1 operation the current value will be 100% and overload condition is about 10% more and for S6 operation about 30% more. The default delay value is 20sec.

✓ Immediate stop because of **exceeding the maximum admissible current** of the converter

✓ **Emergency Stop** because of a valid signal at input Emergency Stop setup in menu "digital inputs"

The following incidents lead to a shut off of the output stage. the spindle will not be braked and will decelerated by its internal losses and friction. This can take quite a long time until standstill depending on its rotary mass. For a safe detection of standstill a speed sensor would be recommended.

✓ Stop due to **short circuit** at spindle connector. The value is defined by internal limits.

✓ Stop because of signal at digital input Power Stage Off setup in menu "digital inputs"
A restart can only be achieved with a systematic Stop/Start-Sequence or with a valid signal at the input "Error Reset". This can be setup in the menu "digital inputs" the power stage will be activated again after 4 sec.

Safe standstill and protection against unintentional startup

The following incidents will shut off the power stage immediately, which makes a **controlled braking and decelerating** to standstill of the spindle not possible. This allows the spindle to run on for a long time.

✓ For this, the condition must be fulfilled that a circuit branch independent of the central processor is available and ensures that the output stage of the converter can only be activated with external signals. This is possible with the SFU0303.

✓ Alternatively, a classic single-channel pulse inhibit (section 7.8) or a dual-channel pulse inhibit in accordance with Safe Torque Off Standard STO according to stop category 0 as in IEC 61800-5-2 (section 7.9) is possible.

Attention:
To enable the output stage of the inverter, these must be wired accordingly. The device cannot be commissioned without these settings.

7.8 Safe Puls Inhibitor acc. EN 954-1 K3 and EN ISO 13849-1 Safe Torque Off One (ST01) = PLd / Kat 3

The pulse inhibitor complies with the guidelines Category3 EN954-1 / EN ISO 13849-1
Safe Torque Off One (ST01) = PLd / Cat 3 for the safe stop of drives and also has a status feedback via the output relay 6 (→ chap. 6.2 / chap. 6.6 / chap. 8.7)

✓ With this single-channel pulse inhibitor, a voltage of 24V must be applied to digital input 2 (X2.2) to activate the output stage.
✓ The voltage for this can be obtained from X2.10, so in the simplest case a bridge from X2.2 - X2.10.
✓ The feedback from the converter about the status of the pulse inhibit, if available, is given on the display of the control unit, at the status LED6 and via the digital output 6 of connector X3 (X3.2).

The feedback is provided via relay 6 SSE: (X3.2) , Desktop/19": (Dsub25.17).
With reference to GND SSE: (X2.9) , Desktop/19": (Dsub25.7,19) 0V or +24V via 10kΩ are output depending on the switching state.

Level	0...3V / GND	20...30V
State Pulse Inhibitor	active	deactivated
	Power Stage Locked	Power Stage released
Relay	open	closed

Possible connection with a PLC:
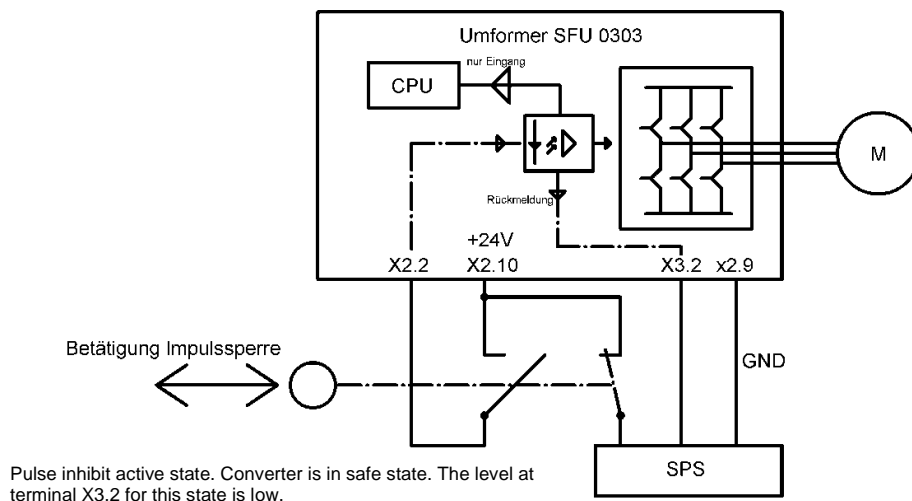
For test purposes only, a jumper can be placed between terminal X2.2 and X2.10 for unlocking.
This enables the inverter, but it must not be used in systems that must be certified according to EN 954-1!

7.9 Safe Torque Off (STO)

As an alternative to the "Single-channel safe pulse inhibit category3 EN954-1" in 7.8, the two-channel function "Safe Torque Off" Safe Torque Off (STO) is also available.

Safe Torque Off (STO) is a safety function to prevent unexpected start-up according to EN 60204-1. The STO function prevents the motor from generating torque and thus corresponds to stop category 0 as specified in IEC 61800-5-2.

Here, the output stage of the inverter can only be enabled by synchronously applying a +24V level to the STO-A and STO-B inputs.
Feedback on the status of the STO is provided via the display of the control unit ("STO ImpLock" / "STO Error "), at the status LEDs and via the STO feedback contact X5.1/X5.2 at connector X5 (chap. 6.4 / 7.9).

STO Safety hints

→ The STO state does not guarantee protection against electric shock

→ If the STO is triggered during operation, the output stage is deactivated immediately. A rotating spindle **can no longer be braked and will slowly coast to a stop**.
This means that a certain amount of time passes until the drive no longer performs a dangerous movement and the safe state is reached.

→ Monitoring whether or when the drive reaches the safe state is not integrated..

Function and application
- Function "Safe Torque Off" (STO)
- Potential-free feedback contact for the operating status

Description of the STO safety function
By using the "Safe Torque Off" function (STO Safe Torque Off), the pulse control to the motor can be interrupted in the application so that it can no longer execute torque or rotary motion.
The STO safety circuit is implemented in the SFU0303 as follows:
The control signals to the output stage are routed via optocouplers. When the STO function is triggered, the power supply to the optocouplers is interrupted twice. This interrupts the isolating point to the output circuit and no output pulses can be generated.
The drive can therefore no longer execute any dangerous movements.

The two control inputs STO-A and STO-B are used to request the STO safety function on two channels. The two channels are potential-free to the inverter and also to each other and protected against polarity reversal.

Functional description

- STO is activated:
If both control inputs STO-A and STO-B are not connected or are at 0 volts or the supply voltage of the STO logic is missing, the STO function is activated and the output stage is switched off.
power stage is switched off LED3 and LED6 = ON

- STO is deactivated
If both control inputs STO-A and STO-B are connected with +24V, the STO function is deactivated and the output stage is enabled.

- STO Error
In both cases, it must be noted that both inputs must be connected synchronously, within a certain discrepancy time with the same levels. If the levels of the two channels are not equal, this is interpreted as an error and leads to an error message and shutdown of the inverter. The STO function is permanently activated and the inverter is set to the blocking state and the power stage is switched off.
power stage is switched off LED1 and LED4 = ON / LED 3 and LED6 are flashing. The inverter can only be unlocked by switching the mains voltage off and on again.

Control inputs STO-A and STO-B
STO channels 1 and 2 and the feedback contact are galvanically isolated from each other and from all other inputs and outputs
The STO inputs tolerate voltages with levels of ±60-V and have reverse polarity protection that meets the characteristics of IEC 61131-2 types 1, 2 and 3.

Level STO-A/B	0…5V = low	5,1V…..14,9V	15…30V (max. 60V) =high
StateSTO	STO active	not defined	STO inactive
	Inverter disabled and locked	not defined	Inverter enabled and ready for operation
Relay	open	not defined	closed

Discrepancy time t$_{Dis}$
According to the specification of the safety function STO, both levels must always be identical, otherwise the inverter is set to the disabled state and can only be unlocked by switching the mains voltage off and on again.
At the same time, an error message is output on the display ("STO Error") and the LEDs.
The microcontroller of the inverter monitors the evaluation of the two inputs STO-A and STO-B for synchronicity and equality.
The software tolerates a certain discrepancy time in which the inputs can be different, this can be caused e.g. by bouncing of contacts.
→ Discrepancy time: 100 msec.

Test pulses

Test pulses from safety devices are tolerated within a certain range, but are not evaluated and do not lead to STO being switched off

→ OSSD signals with a test pulse length of max. 3.5 ms are tolerated at 24 volts.

Rückmeldekontakt STO

✓ is open when STO is active the inverter is inhibited

    - if no signal or 0V is applied to the control inputs STO-A and STO-B
    - when only one input is energized. STO error
    - if the supply voltage of the STO logic unit is missing or has failed.

✓ The feedback contact is closed when STO is inactive, the inverter is enabled

> **Attention:**
> **The feedback contact has only a single-channel design and may therefore only be used for monitoring, but not in the safety circuit.**

Timing STO
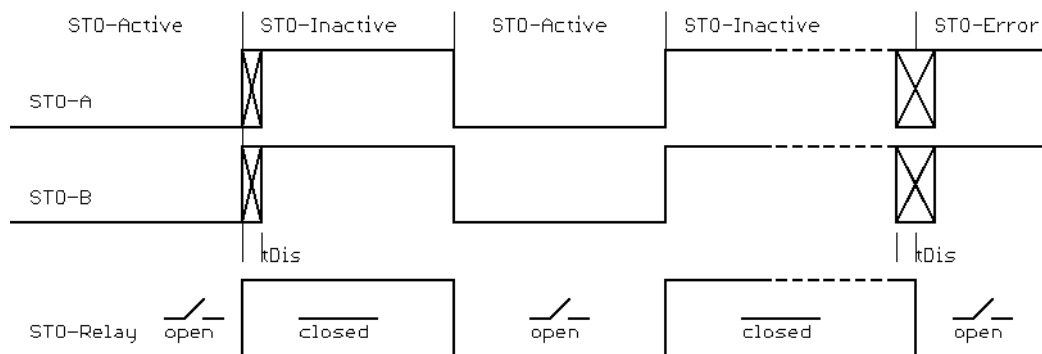
✓ STO channels 1 and 2 and the feedback contact are galvanically isolated from each other and from all other inputs and outputs

✓ The relay normally open contact between pins 1 and 2 is potential-free and is used to provide feedback on the status of the STO:

8   Profibus

For operating the SFU0303 within a profibus dp fieldbus a separate module is available as option. This
ensures an implementation according standards.
It will be mounted instead of the operating panel on interface X1.

The setup of the address is carried out with RS232, a specific connection cable and SFU-Terminal.

The require files including the description of the commands and gsd-files are available on the BMR
website.

It has the same basic setup possibilities as with the standard operating panel.

9 Setup, Parameterization and Configuration with SFU-Terminal

The software **SFU-Terminal** is a tool for the configuration of BMR frequency converters of the series SFU0102....SFU0601.

A manual for SFU-Terminal is available on our website

Moreover, it offers the possibility to read out system data and to modify them.

To achieve this, the following steps should be taken:

1. Install the setup file according the installation software.
2. Power On the converter and establish the connection via USB / RS232.
3. Launch the program *SFUTerminal.EXE*
4. If the connection is established correctly, the program detects the converter automatically. In this case, the firmware of the converter is displayed in SFU-Terminal.
5. By click on **Start** it will at first carried out an upload of all parameters of the converter, a so called "project".
6. The program can be started "Offline" without a connected converter, too. The required converter can be selected manually from a list.
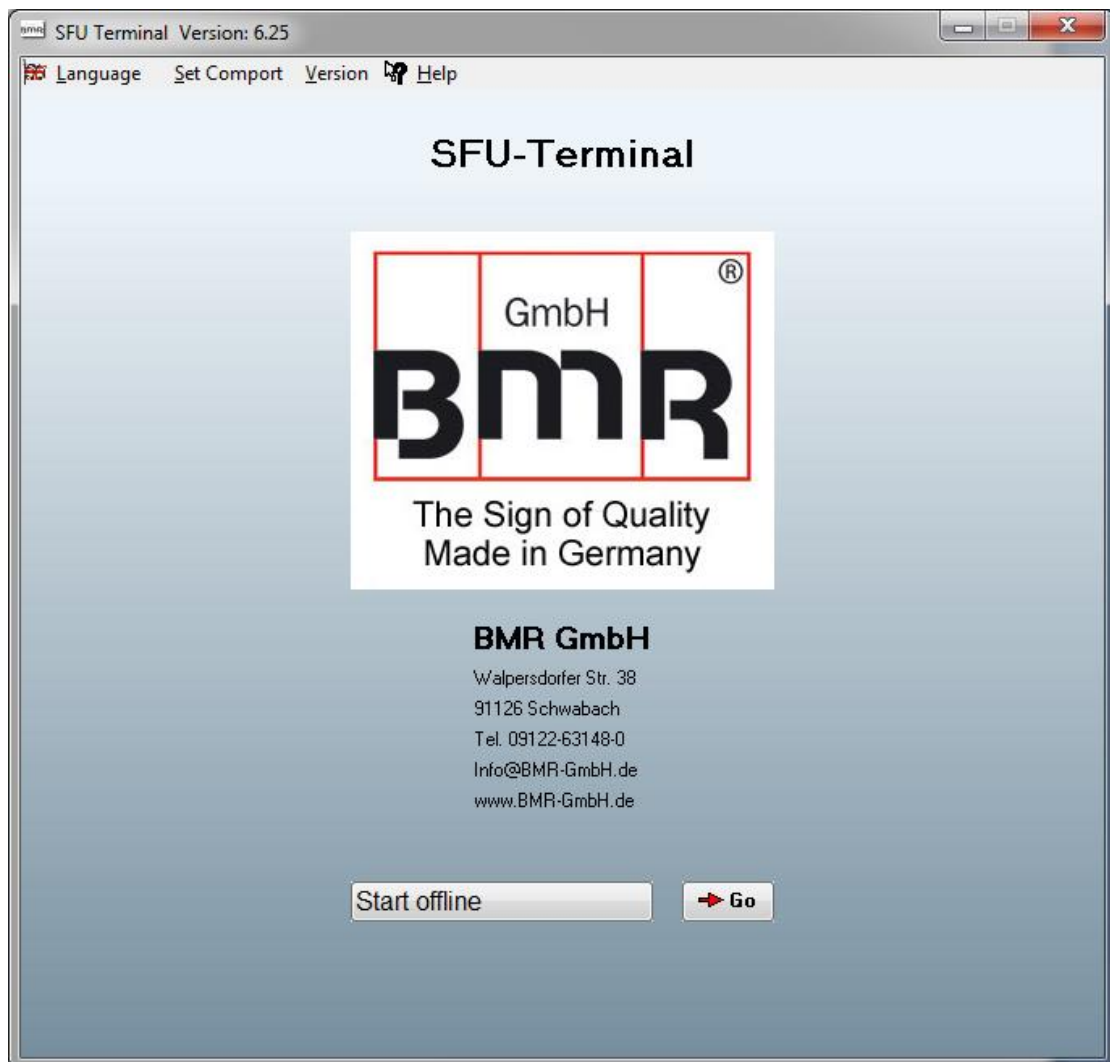
10 Automatic Spindle Tuning and Calibration (Autotuning)

If a motor without having a spindle characteristic has to operated with SFU0303, it can be created very simple with the help of this tool in SFU-Terminal. The spindle is connected with the converter and the converter is connected with a PC and in the menu "Tools" the tool "Automatic Diagram" is started.

Simply the basic data of the spindle have to be input. Important is to mention the nominal voltage according to the proper speed value. The reason for this is, that AC-motors can be operated in a weakened field mode, also, which makes possible a higher rotational speed but with reduced power.

> **ATTENTION:**
> **A spindle characteristic generated by this procedure will be good and to be used in standard applications, but it will never be as perfect as realized manually. So, to achieve best possible performance in an application, it might require a subsequent fine tuning by hand.**

Example 1, normal adjustment:
A 2-pole motor with a maximum rotational speed of 30.000rpm needs at this point a nominal voltage of 220V at a current of 5A .

Example 2, operation in field weakening:
A 2-pole motor with a maximum rotational speed of 30.000rpm needs at 20.000rpm a nominal voltage of 220V at a current of 5A . But the voltage cannot be raised further, so the desired speed can be achieved but with reduced power.

The current limit, in this case 8A, indicates the S6 mode, where it is 5A as the nominal current for the S1 mode.

The acceleration values (Ramp up/down) should be setup to be 12000rpm/sec. It has to be ensured that the shaft can rotate freely.

Start the automatic and save the characteristic after having finished the procedure. Download it into the converter.
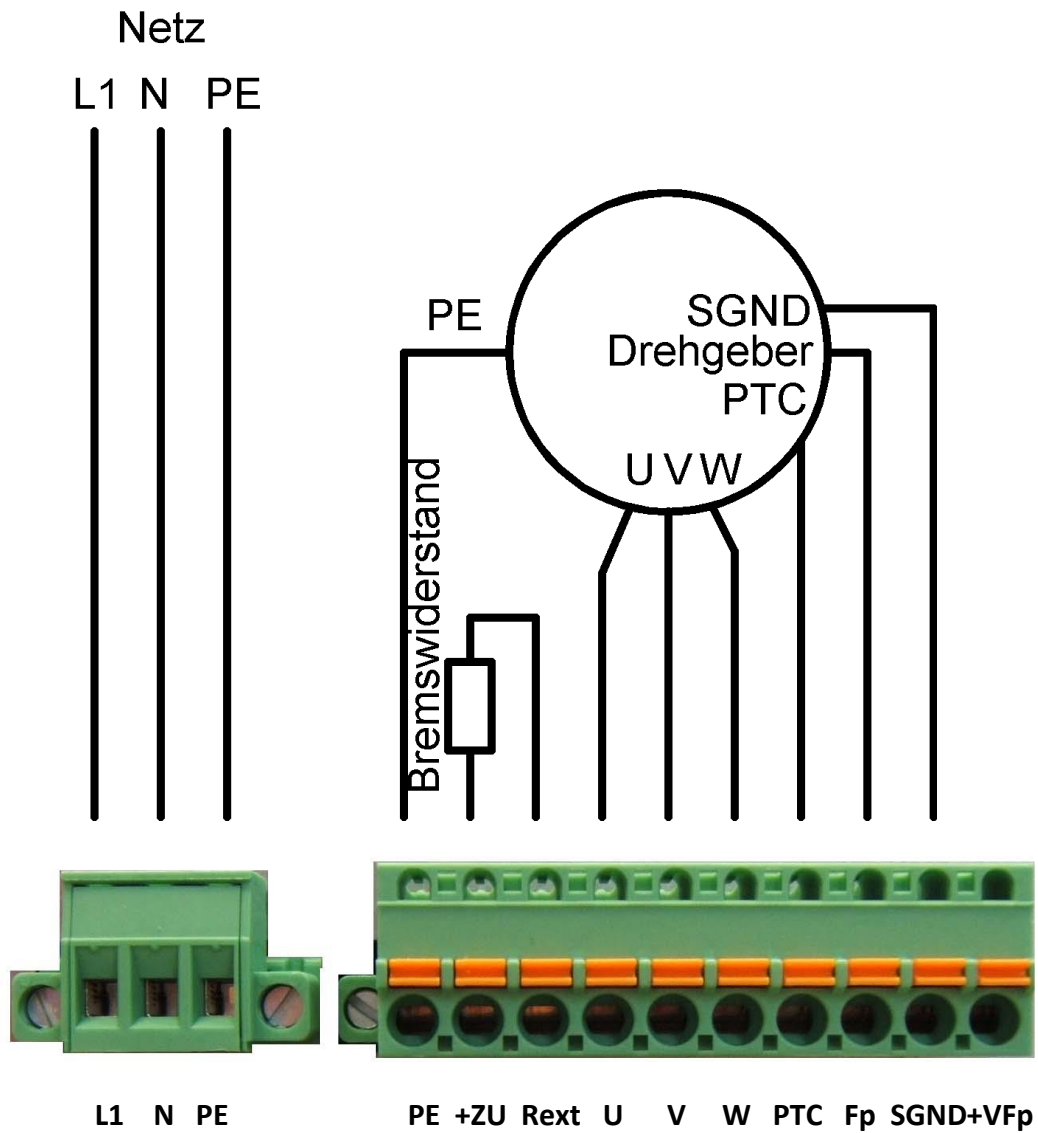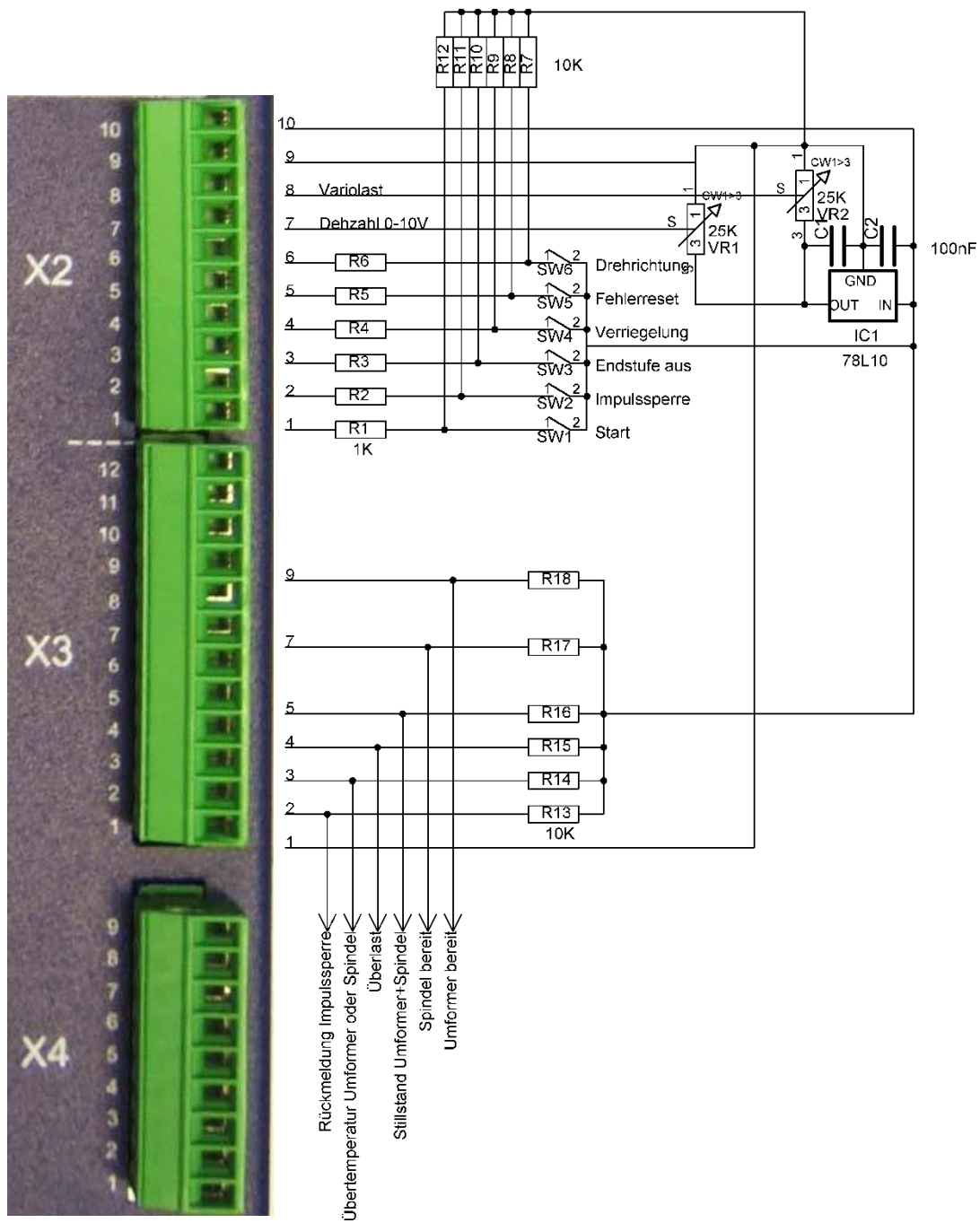
ATTENTION:
If using this autotuning, damages at spindles or the converter due to possible wrong input values are not part of any warranty.

11 Examples of Connection

11.1 Mains and Spindle connection

11.2 Example for Logic and Wiring for Safety Circuit

The spindle interface X4 isn't wired, because the use is depending strongly on the configuration of the spindle and the according its specific characteristic.

This interface in combination with an automatic spindle detection should be used only after consultation with BMR.

By assigning the four address lines the spindle characteristic can be selected by an PLC or external switches, in case it has been enabled
The digital wiring can even be achieved with outputs of logic circuits, with a High Out level > 20V.

The picture shows a configuration with passive switches in combination with the auxiliary voltage of the converter.

For stabilizing the reference analogue voltage for the duty speed a voltage regulator 7810 is used. In combination with a PLC generally a D/A-converter with 10V output level is used

The outputs are executed in such a way that the logic levels 0V and +24V are generated by the galvanically separated relays. For any other arrangement, the relay contacts can be wired and used freely. In the arrangement shown above, the logic level is assigned to the GND of the converter. The outputs shown in the diagram can be used directly as feed into a PLC.

Description of the behaviour during Start with released analogue input: Scaling:0-10V/MinMax

Enabling via input "digital start" – the spindle starts as soon as the level at the analogue input "duty speed" is higher than the minimum rotational speed limit being setup in spindle characteristic. It will stop, as soon as either "digital start" is low or the level at analogue input "duty speed" is below the minimum rotational speed limit.
In case of applying 10V to "analogue input "duty speed" and 16V to "digital start", the spindle will accelerate up to maximum speed.

12 EMC

✓ This unit is designed **for operation in industrial environments only**. When used in residential and commercial areas, additional measures may be required to limit the emitted interference.

✓ The compliance with the limit values of EMC is the responsibility of the manufacturer of the machine or device.

✓ This device was developed for use in industrial environments. For trouble-free operation and to reduce emitted interference, the following should be observed during wiring of the equipment:

✓ The EMC of a machine or device is affected by all connected components (motor spindle, length and type of cables, wiring, etc..). Under certain conditions the use of additional filters can be necessary to maintain the current laws.

✓ The earth and shield connections of all those devices used in conjunction with the frequency converter should be as short as possible and have as large a cross-section as possible.

✓ Control devices used with the frequency converter (PLC, CNC, IPC, ...) should be connected to a common earth/earth terminal bar

✓ All connections both to and from the frequency converter should be via shielded cable.

✓ Supply cables, motor cables and control cables must be completely isolated from each other. Where crossing cannot be avoided, cables should be laid at 90° to each other.

✓ The control cable should be laid as far away as possible from the load cable.

13 Troubleshooting

Error Description	Cause	Fixing
After power on the converter indicates **Not Ready** and **Error**	Input "Emergency Stop" is not properly or not wired at all.	+24Signal at this input
	The converter is at excess temperature	> Let the converter cool down > Check, if the fan is working properly or maintain that air flow around the heatsink is sufficient > Slow down the tooling process
	Pulse inhibitor circuit is engaged, at devices with such a circuit (SFU0303)	> For disengaging wire +24V to the appropriate Pin > Wire a bridge between X2.1 - X2.10 (SFU0303)
	A spindle diagram which is not valid is selected	Change spindle characteristic with the help of the front panel keys or with SFU-Terminal
	Short circuit detection of the out put has tripped	> Check, if the spindle is blocked > Check, if there is a short circuit within the spindle > Check, if there is a Ground fault (at least one prng of the spindle cable is connected with PE) > Check, if there is a short circuit within the spindle cable
After power on the converter indicates **Not Ready** and **Error** and the evaluation of the temperature sensor is activated in the spindle characteristic	No spindle connected	Connect spindle
	No temperature sensor present within the spindle	Disable in spindle characteristic menu in SFU-Terminal the Temperature Sensor button
	Temperature sensor of the spindle defective	> Change spindle > Disable in SFU-Terminal in spindle characteristic menu the Temperature Sensor button

Error Description	Cause	Fixing
In case of connecting the converter with a PC or after launching the SW SFU-Terminal the **Converter is not detected and not recognized**	Incorrect connection cable or wiring fault	> Check cable for proper Pinout. > Verify at USB cables that it's length is not longer than 2m > Try to use original BMR cables, only
	In case of using RS232	> Use the USB-Interface at the PC together with a USB-RS232 converter. > For use with SFU 0303 a specific RS232 cable is required
	In case of using a USB-RS232 converter the USB-driver is not installed correctly.	install driver
	unsure	Restart SFU-Terminal
Start with push **buttons** not possible	Start button deactivated	Enable Start button by un-checking the checkbox "Block Start Button"
Spindle does not start, in spite of a valid signal for Start	An input is assigned with the function **Emergency Stop** and configured as "Low Active." > This is default state on delivery	> For unlocking, a signal of "HI" / +24V is required at this input. > Deactivate this function or setup as "High Active"
	The evalution of the temperature sensor is activated in the spindle characteristic, but it is not connected or a sensor isn't implemented within the spindle -> in this case Error is indicated, additionally	> Connect the temp sensor wires with the SFU. > uncheck the button "Temp Sensor" in the spindle characteristic in SFU-Terminal
	The spindle test is engaged	> Check cable and connections for proper wiring or short circuit > Check spindle

Error Description	Cause	Fixing
Spindle does not start, in spite of a valid signal for Start	Spindle cable and spindle are OK, and the spindle test is activated > Spindle cable is too long With activated spindle test, a test current is send via spindle cable to the spindle by applyung a voltage at output lines. In case that this current is too low, or a wrong spindle characteristic selected, it does not match to the reference values and the spindle test fails.	> Select correct spindle characteristic > In the spindle characteristic the value of the start voltage has to be increased. -> contact BMR
The error message **Spindle not ready** is indicated.	Spindle is at excess temperature	Let it cool down > Check, if the characteristic matches with the spindle
	PTC in the spindle is defective	change spindle
	The PTC-wires within the spindle cable are defective	exchange cable or fix the connection
Start via Digital Input is not possible	Start via Analogue input is activated.	Deactivate Start via analogue input. -> Manual: "Analogue Inputs" and activate Digital Start
	Set value for duty speed is too low	Increase Analogue value for duty value. > A spindle start is carried out after reaching the required minimum voltage according to the scaling, only
It is displayed **Error Char xx** or **E xx**	The selected spindle characteristic at memory place xx is wrong, invalid or corrupted.	> Select matching characteristic with the help of the buttons at the front panel or with SFU-Terminal -> Contact BMR

Error Description	Cause	Fixing
With activated speed sensor: The spindle runs properly, but sometimes there appears the message **Encoder Error.**	Loose connection in spindle, spindle cable or at the connectors	> Check spindle cable and exchange potentially > Check connectors
	Disturbanes on the signal or the signal amplitude is too low > sensor wires in spindle cable are not shielded	> Exchange spindle cable > for verification test exchange spindle
Error **Without Spindle, Cable** is desplayed	Spindle cable is defective	> Check the 3 spindle phase wires
	Spindle cable too long - With activated spindle test, a test current is send via spindle cable to the spindle by applying a voltage at output lines. In case that this current is too low, or a wrong spindle characteristic selected, it does not match to the reference values and the spindle test fails.	> Check, if the proper characteristic is selected. > Increase value for start voltage in the spindle characteristic -> contact BMR > Deactivate function "Spindle test"

14 General Hints

Our frequency converters are highly valuable precision devices. Please take care of them with the necessary attention, to preserve their high precision, high power ability, and long lifetime.

These devices leave our company only after a quality test and a full load check have been carried out. Before mounting and use, please read the attached manual carefully and pay attention to the points listed below.

✓ Before first activation of the device, verify, if it is in a faultless condition. If it was damaged during shipping and transportation it must not be switched on.

✓ During installation the safety regulations have to be observed.

✓ Before the device is turned on for the first time, it should be verified, that the connected parts cannot carry out uncontrolled movements.

✓ The frequency converter must not be operated close to heating devices or magnets or devices generating strong magnetic fields.

✓ The maximum permissible ambient temperature of this device is from +41 °F till +104 °F.

✓ Sufficient air circulation around the converter should be ensured

✓ Fluids should be prevented from intruding into the housing. If it seems to be happened, the converter has to be switched off immediately.

✓ The relative humidity must not exceed 90% (not condensed).

✓ The ambient air must not use aggressive, flammable or electrically conductive substances and should be as free of dust as possible.

✓ All repairs and maintenance on the converter and the relating accessories must be carried out by skilled personal and with powered off, only. To ensure this, the mains plug should be pulled out. In doing this, both the terms of regulations for preventing accidents and the general and national rules for mounting and safety have to be applied.

✓ The device must not be operated without properly connected PE connection and it has to be verified that the mains connector is fixed with screws, if detachable.

> Our common hints can give only a rough guideline because it is not possible for **BMR GmbH** to cover all specific situations. The compliance with limits of EMC demanded by law is the responsibility of the manufacturer of the unit or the machine. By doing controls and tests in our laboratory or in delegated test-laboratories, BMR takes care, that our products comply with the corresponding standards, in case they are installed appropriately.

15 Warranty

With exclusion of additional claims we give a warranty on our Frequency Converters for 1 year on errors due to material, mounting and construction.

We commit to repair or replace the parts without any costs which seem to be defective by our estimation and which are not damaged by appropriate handling.

Warranty claims have to be sent to us in written form. The customer has to pay the costs to send the defective device back to BMR within the time of warranty. If this is not complied with or if we detect an external intrusion into our device, we feel free to withdraw our duty of warranty.

Our duty of warranty is limited to the repairing or replacing of the defective parts. We refuse claims of responsibility or warranty for direct or indirect consequential damages, caused by faults of our products.

Changes in construction may be carried out without any message or notification.
Our common terms of business conditions apply.

BMR GmbH is a dynamic and flexible company. We take into account specific requirements of our customers as well as demanding solutions in design. These are integrated according to qualitative and functional aspects maintaining of course our high quality standard.
Our company is working according to the highest economical and ecological standards which are mirrored at **BMR GmbH** in all areas. Especially in manufacturing, we try to improve steadily our ecological standard. It has been and is our constant purpose to comply with these demands.
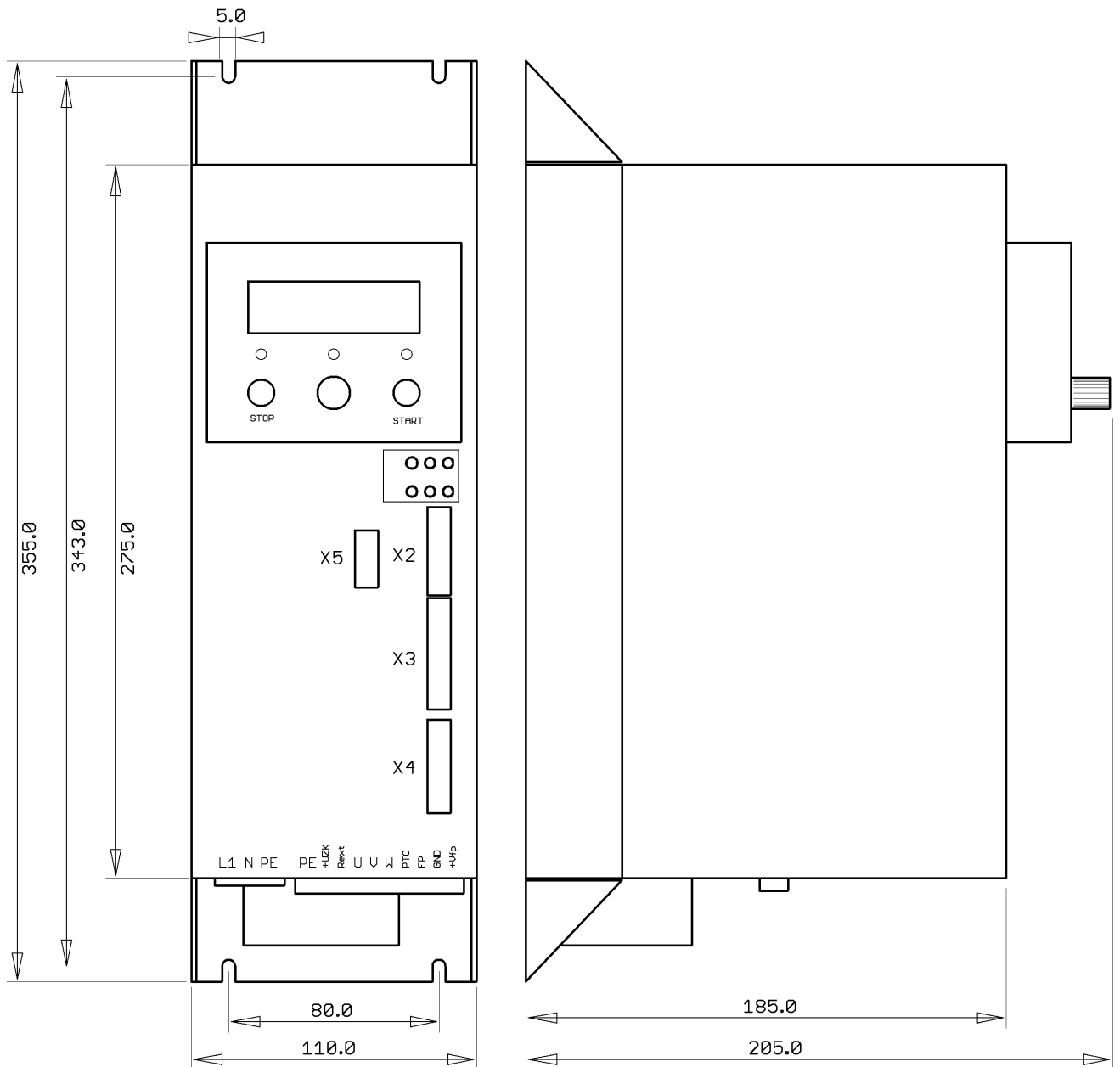
16 Accessories

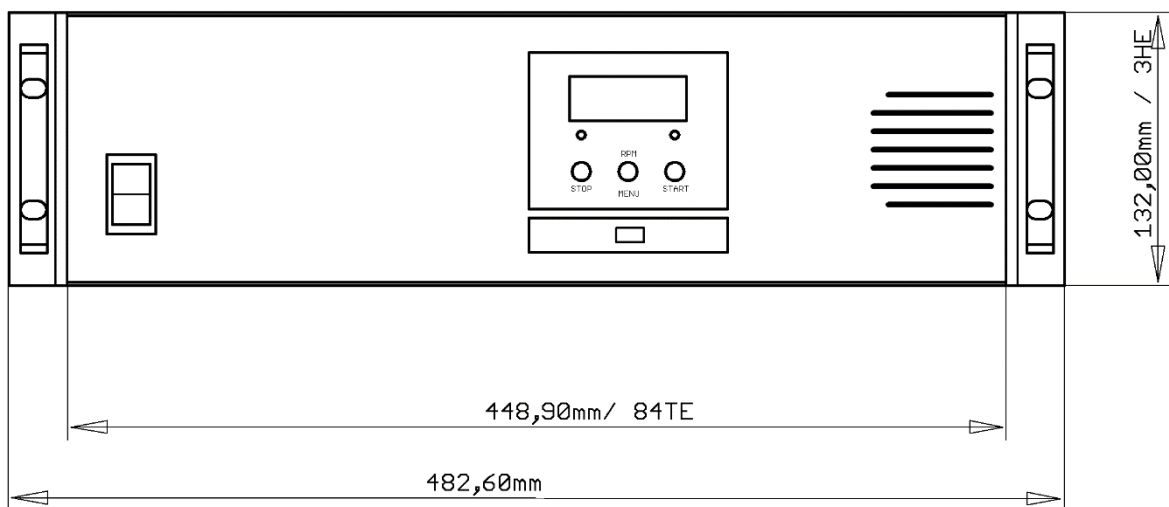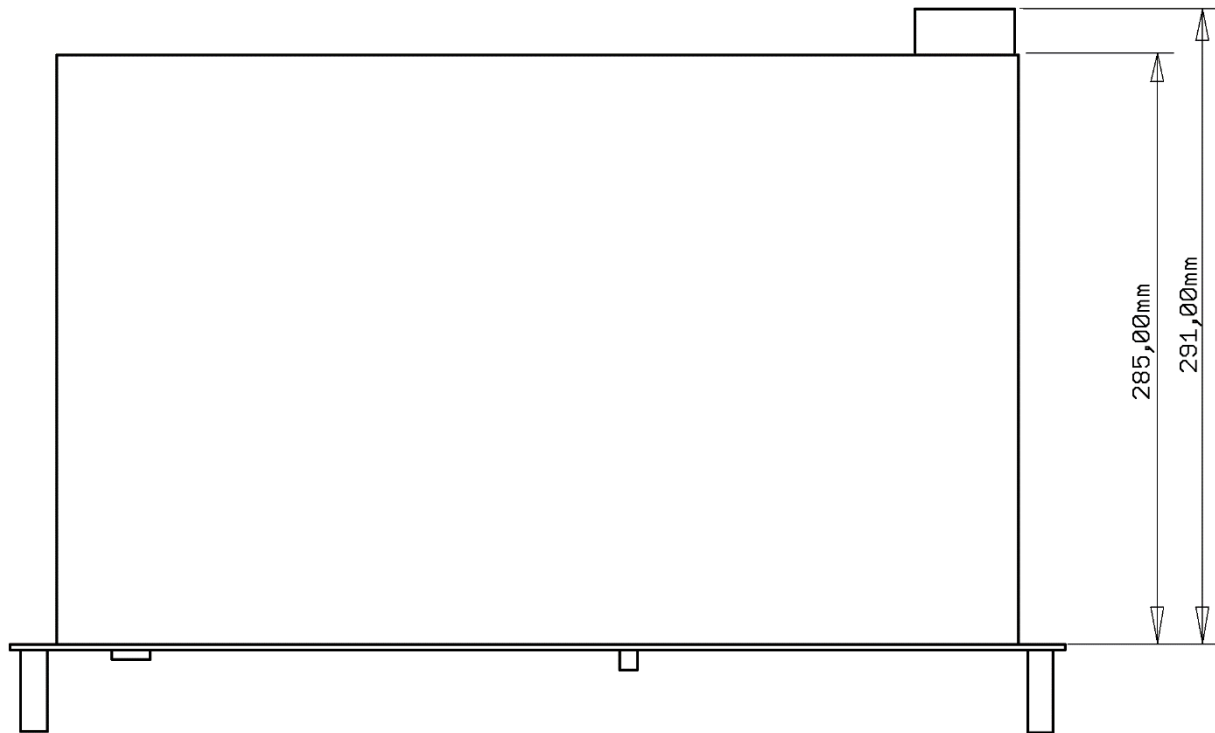| Name	Order code
RS232 Cable	P 2001.100012
USB Cable	P 2001.100013
RS485 Cable	P 2001.100014
LCD Operating Panel	P 1203.100003
Mounting Bracket for the Housing	P 1700.504133
Kit of pluggable Connection Clamps for X2, X3, X4, Mains and spindle connector	P 1001.100005
Mounting Bracket and 2 Clamps for fixing the cables and for establishing the cable shielding	P 1001.100006
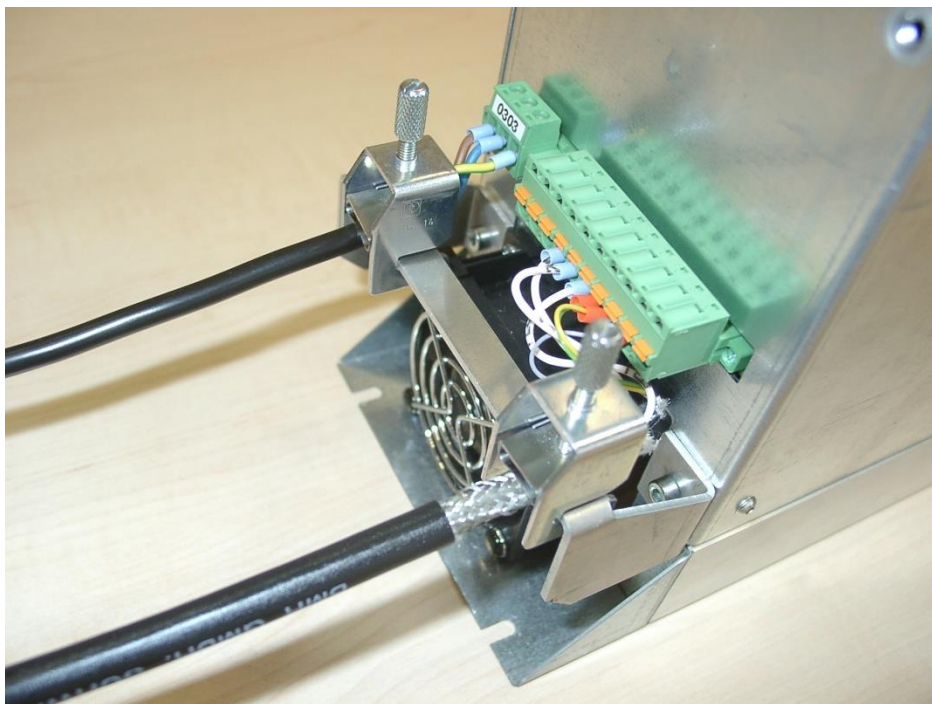
Mounting of cable clamps at the mounting brackets for mains and spindle cables
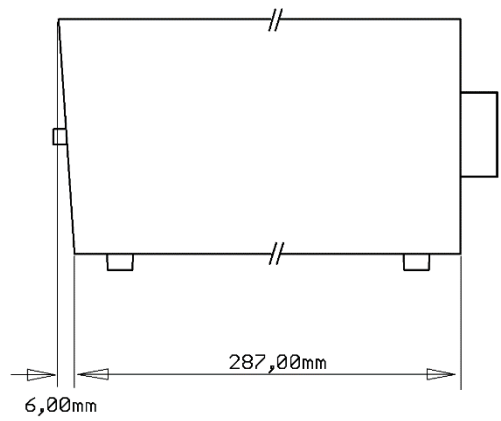
17 Mechanic, Views and Dimension

17.1 SSE Version for cabinet mounting
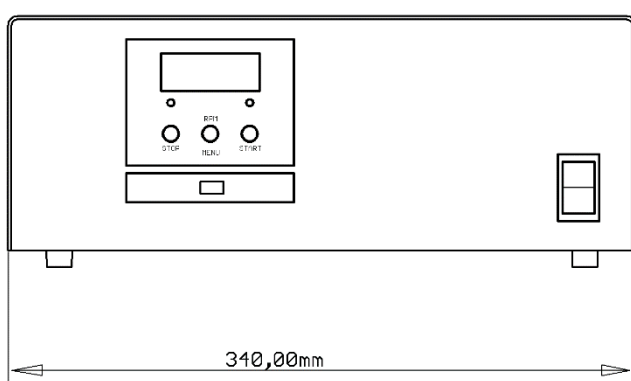
17.2 19" Version

285,00mm
291,00mm

132,00mm / 3HE

448,90mm/ 84TE
482,60mm

17.3 Version Desktop

287,00mm
293,00mm
6,00mm

124,00mm

340,00mm

287,00mm

6,00mm

RPM
STOP   MENU   START
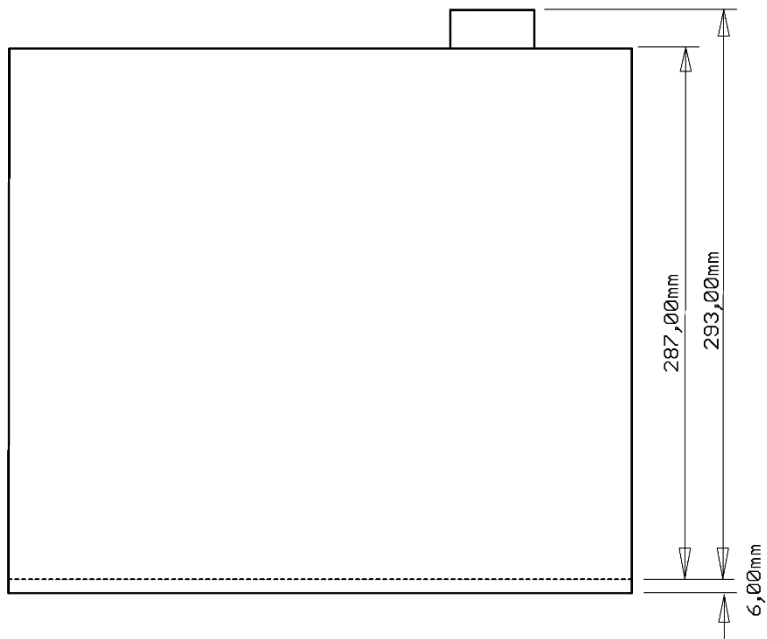
Cooling Unit KG-T 500

Nominal Voltage:	100 - 250 V_{AC} / f=50Hz
Start Input Voltage:	max. 24 V_{DC}
Max. power input:	max. 80W
Max. cooling power:	max. 500W (by ambient temperature<23°C)
Relais details:	max. 30W (30V_{DC} / 1A)
Fuses:	2 A

The cooling unit KG-T 500 is controlled by an internal microprocessor. It has been designed to run high speed spindles like in cool ambience conditions. You are able to use it nearly for all types of spindles and cooling blocks. The maximum range of spindle power is 2000W.

SFU 0156 „Remote-Control"

Als Option ist ein Fernsteuer-Adapter zum direkten Anschluss an das I/O Interface an der Stiftleiste SL2 verfügbar.

✓ On option a remote controller is available which can directly be connected with the I/O interface at SL2.
By this, the required duty speed can be adjusted with a potentiometer and the converter can be started and stopped with a rocker switch.
The status of the digital outputs is indicated on LEDs.

✓ All required voltages are generated within this adapter, so the converter can be controlled and tested very easily.
A quick test and setting into action of the converter becomes possible even without external control signals.

Spindle-Illumination-Ring

Don't you know the problem, that despite of lighting systems, exactly at the point where you need to see something, a shadow appears or there is too less light?

Optionales Zubehör:

With the new spindle illumination ring of **BMR GmbH** this problem belongs to the past!

Spindles

High - frequency spindles are essential in today's adaption technology.
Each application requires a specific solution.

Jäger High Performance Spindles

IMT

SycoTec

IBAG

precise - FRANCE
ELECTROBROCHES - U.G.V. www.precise.fr

ZWANZIG
HSC-DRIVE-SYSTEMS

Henninger
PRÄZISIONSTECHNIK

....and many more!

OUR QUALITY COMMITMENT

100%	„Made in Germany"
100%	precision
100%	reliability
100%	support
100%	flexibility

Technische Änderungen vorbehalten.
November 2021

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